A STUDY OF NEUROGENIC BLADDER IN CHILDREN

MANAGED BY

BOTH CONSERVATIVE LINE AND SURGERY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF **MCh BRANCH (PAEDIATRC SURGERY)** EXAMINATION OF THE DR. M.G.R. MEDICAL UNIVERSITY , TAMIL NADU, CHENNAI TO BE HELD IN AUGUST 2010.

Abstract

Title : Profile of children presenting with neurogenic bladder to Christian Medical College, Vellore, between Janaury 2003 to December 2008, their management and follow up –A Descriptive study.

Background: Neurogenic bladder sphincter dysfunction (NBSD) can develop as a result of a lesion at any level in the nervous system, including the cerebral cortex, spinal cord, or peripheral nervous system. Neurologic conditions in children leading to neurogenic bladder dysfunction are predominantly congenital neural tube defects (including myelomeningocele, lipomeningocele, sacral agenesis, and occult lesions causing tethered cord). Acquired causes such as spinal cord tumors or trauma or sequelae of transverse myelitis are less frequent. Whereas from an etiologic standpoint neurogenic bladder dysfunction is a heterogeneous group, medical management will be similar irrespective of the underlying cause.

Materials and Methods: This is a retrospective analysis of all children with neurogenic bladder admitted in Department of Paediatric Surgery, Christian Medical college ,Vellore during 2003 to 2008.The operative data and follow up data were collected from their hospital charts.

Patients: A total of 194 patients were admitted between January 2003 to December 2008 with neurogenic bladder. 131 patients came for follow up and their follow up data is available.

Mean follow up period was 3.08 years(Range 1year to 16 years).

Results : Children were grouped into two categories based on their management .One group consisted of children managed with conservative line and other group constituted children managed with surgery.A total of 128 (65.9%) children were managed conservatively, only 76 children came for follow up.A total of 66 children were managed by surgery and 57 children came for follow up.

Most common etiology being meningomyelocele constituting 122 (62.8%) childrens.

Most patients presented with serum creatinine less than 1mg%,only 18 children (1%)presented with serum creatinine above 1 mg%.

92 (48.1%) patients presented with normal preserved upper tracts and 68(35%) of patients presented with moderate to gross hydro-ureteronephrosis.31(16%) patients had mild hydronephrosis.

There were total of 116 (33.3%) refluxing ureters.Of which 41(11.8%) were minor refluxing ureters and 75 (21.5%) were major refluxing ureters.

Bladder trabeculation in cystourethrogram was found in 144 (82.7%) children.

Conservative (medical) management:patients were managed with CIC and oxybutynin.

A total of 128 (65.9%) patents were managed with CIC & oxybutynin. 76 patients came for follow up.7 children were irregular in their CIC who were readmitted and importance of CIC was reinforced.69 children were regular and compliant in their CIC and were dry in between CIC.

Surgery: A total of 66 (34.1%) patients underwent surgical procedure for management of neurogenic bladder. Most common surgery was augmentation cystoplasty using bowel done in 47 patients Ureteric reimplant with appendicular Mitrofanoff done in 12 patients,Vesicostomy or Ureterostomy done in 7 patients.

CONCLUSION:

Medical management with CIC and anticholinergics is effective in preserving renal function and providing safe urinary continence in more than 90% of patients with a neurogenic bladder. Early diagnosis and treatment institution, long before continence becomes an issue at toddler age, can prevent both renal damage and secondary bladder-wall changes, thereby improving long-term outcomes. Augmentation cystoplasty is indicated where conservative line of management has failed.

INTRODUCTION

Neurogenic bladder sphincter dysfunction (NBSD) can develop as a result of a lesion at any level in the nervous system, including the cerebral cortex, spinal cord, or peripheral nervous system. Neurologic conditions in children leading to neurogenic bladder dysfunction are predominantly congenital neural tube defects (including myelomeningocele, lipomeningocele, sacral agenesis, and occult lesions causing tethered cord). Acquired causes such as spinal cord tumors or trauma or sequelae of transverse myelitis are less frequent. Whereas from an etiologic standpoint neurogenic bladder dysfunction is a heterogeneous group, medical management will be similar irrespective of the underlying cause. The vast majority of knowledge about NBSD management comes from long-term experience with myelomeningocele (MMC), the most common neural tube defect.

Following the institution of a general treatment policy with advances in neurosurgical and orthopedic treatments in previous decades, governing the associated NBSD has become crucial for improving quality of life and life expectancy in children with neural tube defects. In MMC patients, disordered innervation of the detrusor musculature and external sphincter adversely affects bladder function, which if untreated not only leads to incontinence but also will cause secondary damage and dysfunction of both the upper and lower urinary tracts. Key elements in optimal NBSD management are early diagnosis (including NBSD typology) and early (presymptomatic) institution of adequate medical treatment. There is indeed growing evidence that management decisions made during infancy, which prevent both renal damage and secondary bladder-wall changes, potentially impact long-term outcomes for renal function and safe urinary continence.

Aims and Objectives

Aim:

To evaluate children with neurogenic bladder who presented to our hospital during 2003 to 2008.

Objectives:

1.To evaluate various etiologies for neurogenic bladder in children.

2.To evaluate the general characteristics of children with neurogenic bladder at presentation.

3.To study both conservative and surgical management of children with neurogenic bladder.

4.To follow up the children with regard to upper renal tract status managed by both conservative line and surgery.

REVIEW OF LITERATURE.

Historical Evolution:

The management of NBSD in children has undergone major changes over the years. A first milestone was the introduction of clean intermittent catheterization (CIC) in 1972 [1]. CIC (combined with anticholinergics if required) has made “conservative” (medical) management a successful treatment option, with a good outcome for quality of life and kidney protection. Further important breakthroughs were the wider application of urodynamic testing in the evaluation of infants and young children with suspected NBSD [2–4] and the better pathophysiological understanding of the natural history of NBSD in patients with spina bifida. In spina bifida, the natural history of the urinary tract in untreated NBSD is one of progressive deterioration by the age of 3 years in up to 58% of patients [5]. Several reports have shown this deterioration to be directly related to increased intravesical pressure. In 1981, the bladder pressure at which urethral leakage occurred was found to be a useful predictor of unsafe bladder function [2]. The leak-point pressure, as it is now commonly referred to, has become accepted as one of the urodynamic parameters that allows clinicians to differentiate patients with relatively low or high risk for subsequent upper urinary tract deterioration. In 1984, detrusor external sphincter dyssynergia (DSD) was identified as an important factor leading to functional obstruction, and intravesical pressure was recognized as the pathophysiological mechanism of subsequent upper urinary tract deterioration [3]. Shortly thereafter, urodynamics in infants and children was shown to allow a functional classification of NBSD that correlated with clinical entities of incontinence and obstruction, an approach that has allowed the concept of individualized and presymptomatic therapy in high-risk patients [6].

Neuroanatomy

Normal voiding essentially is a spinal reflex that is modulated by the central nervous system (brain and spinal cord), which coordinates the functions of the bladder and urethra. The bladder and urethra are innervated by 3 sets of peripheral nerves arising from the autonomic nervous system (ANS) and somatic nervous system. The central nervous system is composed of the brain, brain stem, and the spinal cord.

Brain

The brain is the master control of the entire urinary system.

The micturition control center is located in the frontal lobe of the brain. The primary activity of this area is to send tonically inhibitory signals to the detrusor muscle to prevent the bladder from emptying (contracting) until a socially acceptable time and place to urinate is available.

The signal transmitted by the brain is routed through 2 intermediate stops (the brainstem and the sacral spinal cord) prior to reaching the bladder.

Brainstem

The brainstem is located at the base of the skull. Within the brainstem is a specialized area known as the pons, a major relay center between the brain and the bladder. The pons is responsible for coordinating the activities of the urinary sphincters and the bladder so that they work in synergy. The mechanical process of urination is coordinated by the pons in the area known as the pontine micturition center (PMC). The PMC coordinates the urethral sphincter relaxation and detrusor contraction to facilitate urination. The conscious sensations associated with bladder activity are transmitted to the pons from the cerebral cortex. The interaction of a variety of excitatory and inhibitory neuronal systems is the function of the PMC, which is characterized by its inborn excitatory nature. The PMC functions as a relay switch in the voiding pathway. Stimulation of the PMC causes the urethral sphincters to open while facilitating the detrusor to contract and expel the urine.

The PMC is affected by emotions, which is why some people may experience incontinence when they are excited or scared. The ability of the brain to control the PMC is part of the social training that

children experience during growth and development. Usually the brain takes over the control of the pons at age 3-4 years, which is why most children undergo toilet training at this age.

When the bladder becomes full, the stretch receptors of the detrusor muscle send a signal to the pons, which in turn notifies the brain. People perceive this signal (bladder fullness) as a sudden desire to go to the bathroom. Under normal situations, the brain sends an inhibitory signal to the pons to inhibit the bladder from contracting until a bathroom is found.

When the PMC is deactivated, the urge to urinate disappears, allowing the patient to delay urination until finding a socially acceptable time and place. When urination is appropriate, the brain sends excitatory signals to the pons, allowing the urinary sphincters to open and the detrusor to empty.

Spinal cord

The spinal cord extends from the brainstem down to the lumbosacral spine. It is located in the spinal canal and is protected by the cerebrospinal fluid, meninges, and a vertebral column. It is approximately 14 inches long in an adult. Along its course, the spinal cord sprouts off many nerve branches to different parts of the body.

The spinal cord functions as a long communication pathway between the brainstem and the sacral spinal cord. When the sacral cord receives the sensory information from the bladder, this signal travels up the spinal cord to the pons and then ultimately to the brain. The brain interprets this signal and sends a reply via the pons that travels down the spinal cord to the sacral cord and, subsequently, to the bladder.

In the normal cycle of bladder filling and emptying, the spinal cord acts as an important intermediary between the pons and the sacral cord. An intact spinal cord is critical for normal micturition.

If spinal cord injury has occurred, the patient will demonstrate symptoms of urinary frequency, urgency, and urge incontinence but will be unable to empty his or her bladder completely. This occurs because the urinary bladder and the sphincter are both overactive, a condition termed detrusor sphincter dyssynergia with detrusor hyperreflexia (DSD-DH).

The sacral spinal cord is the terminal portion of the spinal cord situated at the lower back in the lumbar area. This is a specialized area of the spinal cord known as the sacral reflex center. It is responsible for bladder contractions. The sacral reflex center is the primitive voiding center.

In infants, the higher center of voiding control (the brain) is not mature enough to command the bladder, which is why control of urination in infants and young children comes from signals sent from the sacral cord. When urine fills the infant bladder, an excitatory signal is sent to the sacral cord. When this signal is received by the sacral cord, the spinal reflex center automatically triggers the detrusor to contract. The result is involuntary detrusor contractions with coordinated voiding.

A continuous cycle of bladder filling and emptying occurs, which is why infants and young children are dependent on diapers until they are toilet trained. As the child's brain matures and develops, it gradually dominates the control of the bladder and the urinary sphincters to inhibit involuntary voiding until complete control is attained. Voluntary continence usually is attained by age 3-4 years. By this time, control of the voiding process has been relinquished by the sacral reflex center of the sacral cord to the higher center in the brain.

If the sacral cord becomes severely injured (eg, spinal tumor, herniated disc), the bladder may not function. Affected patients may develop urinary retention, termed detrusor areflexia. The detrusor will be unable to contract, so the patient will not be able to urinate and urinary retention will occur.

Peripheral nerves

Peripheral nerves form an intricate network of pathways for sending and receiving information throughout the body. The nerves originate from the main trunk of the spinal cord and branch out in different directions to cover the entire body. Nerves convert the internal and external environmental stimuli to electrical signals so that the human body can understand stimuli as one of the ordinary senses (ie, hearing, sight, smell, touch, taste, equilibrium). The bladder and the urethral sphincters are under the influence of their corresponding nerves.

The ANS lies outside of the central nervous system. It regulates the actions of the internal organs (eg, intestines, heart, bladder) under involuntary control. The ANS is divided into the sympathetic and the parasympathetic nervous system.

Under normal conditions, the bladder and the internal urethral sphincter primarily are under sympathetic nervous system control. When the sympathetic nervous system is active, it causes the bladder to increase its capacity without increasing detrusor resting pressure (accommodation) and stimulates the internal urinary sphincter to remain tightly closed. The sympathetic activity also inhibits

parasympathetic stimulation. When the sympathetic nervous system is active, urinary accommodation occurs and the micturition reflex is inhibited.

The parasympathetic nervous system functions in a manner opposite to that of the sympathetic nervous system. In terms of urinary function, the parasympathetic nerves stimulate the detrusor to contract. Immediately preceding parasympathetic stimulation, the sympathetic influence on the internal urethral sphincter becomes suppressed so that the internal sphincter relaxes and opens. In addition, the activity of the pudendal nerve is inhibited to cause the external sphincter to open. The result is facilitation of voluntary urination.

Like the ANS, the somatic nervous system is a part of the nervous system that lies outside of the central spinal cord. The somatic nervous system regulates the actions of the muscles under voluntary control. Examples of these muscles are the external urinary sphincter and the pelvic diaphragm. The pudendal nerve originates from the nucleus of Onuf and regulates the voluntary actions of the external urinary sphincter and the pelvic diaphragm. Activation of the pudendal nerve causes contraction of the external sphincter and the pelvic floor muscles, which occurs with activities such as Kegel exercises. Difficult or prolonged vaginal delivery may cause temporary neurapraxia of the pudendal nerve and cause stress urinary incontinence. Conversely, suprasacral-infrapontine spinal cord trauma can cause overstimulation of the pudendal nerve, resulting in urinary retention.

PATHO-PHYSIOLOGY

Under normal conditions, the detrusor muscle, bladder neck, and striated external sphincter function as a synergistic unit for adequate storage and complete evacuation of urine. In healthy bladders, the change in bladder-filling pressure between empty and full is normally less than 10–15 cm H_2O. Normal voiding pressures for males and females are from 50 to 80 cm H_2O and from 40 to 65 cm H_2O, respectively [7].

In patients with NBSD, disordered innervation of the detrusor musculature and external sphincter adversely affects bladder function. In recent years, it has become clear that children with this condition can be categorized into high- and low-risk groups for secondary damage from a neurogenic bladder based on intravesical pressure. When the detrusor (filling) pressure exceeds 40 cm H_2O, glomerular filtration rate decreases and pyelocaliceal and ureteral drainage deteriorates, leading to obstructive hydronephrosis and/or vesicoureteral reflux [2, 8–10]. Even in the absence of reflux or upper urinary tract dilatation, high intravesical pressure can impair drainage of urine into the bladder. Any pathophysiologic process that causes either intermittent or continuous elevation of bladder pressure above 40 cm H_2O places the child at risk for upper urinary tract dysfunction, urinary tract infections, and ultimately renal failure. Intermittent elevation of bladder pressure may occur from detrusor hypertonia, hyperreflexia, or both. Hyperreflexia may cause intermittent elevation of bladder pressure, especially if the external sphincter acts reflexively and tightens rather than relaxes in an attempt to prevent micturition [detrusor sphincter dyssynergia (DSD)]. Over a long period of time, hyperreflexia with pressures greater than 40 cm H_2O may result in detrusor decompensation (areflexia from myogenic failure) or in detrusor hypertrophy with associated sacculations and subsequent diverticula formation. These pathophysiologic changes affect the elastic and vesicoelastic properties of the bladder and also result in mechanical ureterovesical junction obstruction. Continuous elevation of bladder

pressure above 40 cm H_2O may occur from a hypertonic detrusor or a hypertrophic small-capacity bladder secondary to outflow obstruction [11]. Bladder outlet obstruction is caused by DSD, or by fibrosis of the external urethral sphincter secondary to partial or complete denervation [3, 12, 13]. Bladder outlet obstruction will lead to elevated (pathologic) voiding pressures, which will contribute to either detrusor decompensation or hypertrophy. Finally, recurrent urinary tract infections due to bladder residue may aggravate damage to the neurogenic bladder through processes of transmural inflammation and fibrosis. Together with high intravesical pressures and/or vesicoureteral reflux, these lower urinary tract infections will lead to episodes of acute pyelonephritis and irreversible renal damage.

General principles and treatment goals

The cornerstone of optimal NBSD management is early identification and characterization (typology) and the institution of proactive therapy. Crucial for long-term prognosis of patients with NBSD is the fact that the management must start before consequences of bladder dysfunction become apparent. From the outset, the goals of management are to prevent or minimize secondary damage to the upper urinary tracts and bladder from the primary neurogenic bladder dysfunction and to achieve safe social continence [14]. Thus, long before continence becomes an issue, starting from the first year of life, management is directed at creating a low-pressure reservoir and ensuring complete and safe bladder emptying.

Clean intermittent catheterization (CIC) or self-catheterization (CISC) in combination with anticholinergics (oxybutynin) is the standard therapy for children with neurogenic bladder dysfunction with detrusor hyperactivity and/or DSD [11, 15, 16]. This treatment is also feasible and effective in developing countries, where untreated neuropathic bladder is an important cause of preventable chronic renal failure [17, 18]. CIC enables complete bladder emptying and thus avoids bladder residues and consequent risks for infections. In the high-risk bladder with DSD, CIC also allows bladder emptying before the occurrence of otherwise “spontaneous” high-pressure voiding, which is known to be detrimental for kidney function and drainage. Oxybutynin, a bladder smooth-muscle relaxant, is used to improve bladder dynamics through suppression of detrusor hypertonicity and hyperreflexia. By doing so, oxybutynin eliminates (high-pressure) uninhibited detrusor contractions (and thus urinary leakage) and prevents high-pressure bladder storage (due to detrusor hypertonicity or low bladder compliance) and high-pressure emptying (in case of DSD).

Early management, including diagnosis and identification of the high-risk bladder

At birth, the majority of patients with neurogenic bladder has normal upper urinary tracts. Without proper management, urinary tract infections and elevated bladder pressures with secondary bladder-wall changes may cause upper urinary tract deterioration within 3 years in up to 58% [5]. One third of children who develop impaired kidney drainage do so within the first year of life [19]. The specific abnormalities vary considerably and are not predicted by the level of the spinal cord defect. Furthermore, the dysfunctional pattern may be dynamic, influenced by spinal cord surgery, tethering, and denervation. In the initial baseline evaluation, clinical observations must be completed with urinalysis (microscopy and culture), renal/bladder ultrasound, and cystourethrogram. These allow the experienced clinician to suspect the type of NBSD and to identify the high-risk subgroup. The next consideration is when to perform urodynamic studies.

Two different opinions exist in the literature on the use of urodynamic studies in the early evaluation and further follow-up. In one approach, urodynamic assessment has become an integral part of the initial evaluation and subsequent management, as it allows recognition of the different subtypes of NBSD (typology), proactive interventions, evaluation and guidance of therapy, and early detection of neurologic deterioration (such as symptomatic tethering of the spinal cord [20]). Advocates justify this approach of routine urodynamics to minimize the deleterious effects of high intravesical pressure by directly measuring it rather than indirectly suspecting it from the development of upper and lower urinary tract changes on serial radiologic imaging. Several studies have shown that early urodynamic evaluation of children with NBSD allows the prediction of which newborns are at risk for upper urinary tract deterioration. Urodynamic risk factors are low bladder compliance, intravesical pressure more than 40 cm H_2O, and DSD [2, 3, 6, 21]. The alternative to urodynamic-based

management is serial radiologic imaging to detect secondary evidence of high bladder pressure. Critics of newborn and early infancy urodynamics refer to a lack of standards for performance and interpretation, which might lead to unnecessary interventions [22, 23]. Those authors recommend careful history, physical examination, upper urinary tract imaging, and close follow-up during infancy and childhood, reserving urodynamic studies only for patients with evidence of urinary retention on physical examination, new-onset hydronephrosis or febrile urinary tract infection, or for evaluation to achieve continence. Proponents of this approach with selective urodynamics suggest that close monitoring with prompt intervention at first signs of deterioration is effective in protecting the upper urinary tracts (including preservation of nephrons and thus renal function in the long run). A remaining concern, however, could be that in this more expectant approach, high intravesical pressures may have already resulted in irreversible and avoidable damage to the bladder wall, resulting in small-capacity, low-compliance bladders later in life.

Although many questions regarding optimal evaluation and management remain unanswered, the consensus on the need of close surveillance, especially in the first years of life, plus the possibility that proactive treatment may be better for the bladder in the very long term, emphasize the need for an integrated approach in which clinical observations, serial imaging, and urodynamics are the basis for early adequate treatment.

Urodynamic studies: special considerations in children with NBSD

If properly performed, even with possible shortcomings in newborns and infancy, urodynamic studies allow direct diagnosis of NBSD and recognition of dysfunction subtypes. This functional classification allows adequate treatment for the different types and early proactive treatment for the bladder at risk [6].

It is important for the practitioner to understand the complexities involved in performing urodynamic studies in newborns, infants, and children. Urodynamic assessment can provide

reproducible results in newborns and infants, but it requires attention to mechanical factors and filling rates. The younger the child, the higher the risk that mechanical factors (such as bladder-outlet obstruction by the catheter used for the investigation) may produce artificial information (elevated leak pressure or inability to void). It has also been shown that using a bladder infusion rate as close as possible to the natural filling rate is important for correct assessment of detrusor properties [24]. It is presumed that fast infusion rates overcome vesicoelastic detrusor properties, falsely indicating detrusor hypertonicity [11]. On the other hand, in children who have apparent low-pressure cystograms and who leak during filling (due to sphincter hypoactivity), detrusor hypertonia may be unrecognized [25]. In these children, it is important to perform a provocative study (including bladder neck occlusion with a balloon catheter) to identify unrecognized detrusor hyperactivity prior to bladder-neck surgery for treatment of incontinence. Electromyographic (EMG) evaluation of the external urethral sphincter is required to identify DSD. The use of concentric EMG needles is preferred, as it gives more reliable information than patch electrodes [11]. The combination of X-ray cystography with cystometrogram and sphincter EMG (video urodynamics) allows accurate evaluation of the link between intravesical pressure and vesicoureteral reflux and gives direct visual information of (dys)synergia between detrusor and sphincter mechanisms [26].

Clean intermittent catheterisation

In children with neurogenic bladder, CIC is the first-choice treatment to empty the bladder adequately (no residue, no infection) and safely (prior to high-pressure voiding), and it is a valuable tool for achieving continence. The wide variety of used materials and techniques for CIC does not seem to affect efficacy and safety as long as some basic principles are applied: proper education and training, clean and atraumatic application, and achievement of good patient compliance on a long-term basis. For education, training, and further guidance during

follow-up, a dedicated continence nurse is invaluable. Patients and caregivers must understand what is wrong with the bladder/sphincter and why CIC is proposed for treatment, and they have to learn how to catheterize properly. CIC has been successfully used by parents even in newborns and infants, becoming a part of their everyday routine [27]. Some authors prefer early institution of CIC in all infants with NBSD, given the fact that by the age of 3 years, CIC will be required in all for achieving continence, and given the difficulties of starting CIC at toddler age [28]. Such early institution of CIC seems to improve family compliance and their ability to assist the child in coping with their disease and with CIC [29]. CISC can be successfully taught to boys and girls who are motivated and who have developed the required dexterity, mostly around the age of 6 years. The required frequency of catheterization depends on several factors: fluid intake, bladder capacity, and bladder filling/voiding pressures. In practice, it is recommended to catheterize six times a day in infants (linked with feeding time) and five times a day in school-aged children. Although reported incidences of CIC-related infection risks are variable, it is generally agreed that the risk is low as long as complete bladder emptying is achieved. Furthermore, reused supplies are not related to more urinary tract infections [30]. If symptomatic infections occur, these are mainly caused by incomplete bladder emptying, and CIC appliance by child or caregiver needs to be optimized. To prevent urethral strictures and false passage in boys, catheter lubrication and avoidance of forceful manipulation during catheter insertion are advocated. Nonreusable low-friction catheters are considered valuable in high-risk male patients with urethral false passage or very tense sphincters but are unnecessary in routine cases [31]. To maintain therapeutic compliance with CISC in adolescents, psychosocial support is often required. Neurogenic bowel dysfunction with constipation and fecal soiling can interfere with the institution of a successful CIC treatment. Retained stools may mechanically impair bladder filling, increase detrusor irritability, or contribute to urine retention. Stool

incontinence increases the risk of bladder contamination and urinary tract infection. An effective bowel management program is therefore needed. Finally, given the high prevalence of latex allergy [32], in the spina bifida population, a strict latex-free approach is of extreme importance.

Pharmacologic treatment: anticholinergics

Of the anticholinergic agents available, oxybutynin hydrochloride is most commonly used, and long-term experience supports its safety also in newborns and infants [33]. Oxybutynin is a tertiary amine with a well-documented therapeutic effect on detrusor hyperactivity, and its effectiveness is attributed to a combination of anticholinergic (M3-selective receptor subtype antagonism), antispasmodic, local anesthetic and calcium-channel-blocking activity [34]. Several studies have shown its efficacy for decreasing the filling pressure, increasing the capacity of the neurogenic bladder, and preserving renal function [35–37]. The usual dose regimen of oral oxybutynin is 0.3–0.6 mg/kg per day in three doses.

In children with insufficient response or significant systemic side effects to oral oxybutynin, intravesical instillation of oxybutynin has been shown to be a highly efficacious, reliable, and well-tolerated therapy for children who would otherwise require surgical therapy [38–43]. Because a solution suitable for intravesical instillation was not available, crushed oxybutynin tablets were used in the earlier trials, with consequent problems of inconvenience and impracticability, and it was the belief of several authors that poor patient compliance could be resolved by an optimized drug preparation [40, 44]. It was subsequently shown that, indeed, eliminating the complex crushing preparation by child or parent makes intravesical oxybutynin therapy easy to use and acceptable for long-term therapy [41].

The mechanisms underlying the more potent and longer-acting detrusor-suppressive effects of intravesical oxybutyinin, as well as its better tolerability, have been investigated by several groups. It was demonstrated that a reduced first-pass metabolism of oxybutynin after

intravesical instillation, resulting in a reduced generation of the N-desethyl metabolite, may explain the clinically relevant reduction of systemic side effects that characterizes intravesical compared with oral oxybutynin therapy [45]. In addition, these pharmacokinetic studies provided first evidence for a direct local rather than a systemic effect of intravesical oxybutynin on detrusor muscle [45]. Further evidence for a local effect of intravesically administered oxybutynin was provided by studies showing local (urothelial) accumulation, suppression of muscarinic receptor-mediated detrusor muscle contractions, and blocking of muscarinic receptors in bladder-afferent pathways [46, 47]. In most reports, intravesical oxybutynin is used in dosages between 0.3 and 0.6 mg/kg per day in two or three doses. Given its better tolerability compared with oral treatment, if required, intravesical dosages can be further increased up to doses of 0.9 mg/kg per day [43].

To date, the vast majority (~ 90%) of patients can be treated successfully with the gold standard treatment of oxybutynin (oral or intravesical) and CIC. Other bladder-relaxant drugs include propiverine (10–15 mg b.i.d. or t.i.d., adult dose), trospium (20 mg b.i.d., adult dose), extended-release oxybutynin, and tolterodine (children 0.25–1 mg b.i.d., adults 1–2 mg b.i.d.). The current experience with compounds other than oxybutynin is still limited in children with neurogenic bladder [48, 49]. Botulinum A toxin injections into the detrusor muscle have been shown to be a potentially valuable approach in the neurogenic overactive bladder [50]. Repeated botulinum A toxin injections (as an alternative for or an additive to anticholinergics) could be considered to postpone or avoid surgical procedures in the small minority of children not responding to standard therapy with CIC and anticholinergics [51]. However, further investigations are required, given remaining concerns about costs and long-term efficacy and safety of prolonged botulinum A toxin administration. Although some authors have advocated alfa-receptor stimulation of the bladder neck, no validated medical treatment is available to enhance the bladder outlet.

Medical management of NBSD in clinical practice

Optimal management involves first, early diagnosis, including recognition of high-risk subtypes, and second, proactive institution of adequate treatment. Early proactive treatment of high-pressure dyssynergic lower urinary tracts is important in the long term, not only to preserve renal function [52] but also to prevent poor bladder compliance and the subsequent need for bladder augmentation [35]. Urodynamic assessment is used in newborns and infants to come to a functional classification of NBSD, allowing presymptomatic interventions in the high-risk groups and individualized treatment planning according to the type of dysfunction [6, 29, 53].

In clinical practice, four major subtypes can be used to describe NBSD : Sphincter overactivity combined with detrusor underactivity (type A) or overactivity (type B), and sphincter underactivity combined with detrusor underactivity (type C) or with detrusor overactivity (type D). The easiest type to treat is type A. This bladder type requires early treatment because of urine retention with high filling pressure and continuous leaking. Here, CIC alone is effective and sufficient and will make the bladder safe and infection free, and the patient will be dry in between (social continence). Good care to empty the bladder totally is most important to avoid bladder infections caused by residual urine. Dysfunctional type B will have high filling and high voiding pressures, being very unsafe from birth onward due to DSD. Here, the act of voiding has to be prevented. With oxybutynin, the overactive detrusor can be “pharmacologically converted” to an inactive reservoir (situation similar to type A), which has to be emptied with CIC. In type C, CIC reduces the degree of incontinence and offers much better control over urinary tract infections. To achieve continence, this type will at a later age need surgical intervention on the sphincter (e.g. sling operation). An important caveat here is that detrusor instability may emerge only after surgical improvement of outlet resistance. If this detrusor instability would remain unrecognized and untreated (with

oxybutynin), bladder-outlet surgery would have converted a “wet but safe” into a “dry but unsafe” bladder. In the last dysfunctional subtype (type D), the bladder leaks due to detrusor instability and gradually becomes unsafe due to secondary bladder-wall changes with detrusor hypertrophy and loss of bladder compliance. Therefore, treatment consists of CIC combined with oxybutynin and, at a later age, bladder-outlet surgery.

Once appropriate therapy has been initiated, adequate follow-up is required, with adjustments if needed (CIC frequency, medication dosing and administration route). Treatment efficacy can be assessed using clinical parameters (including CIC frequency and volume charts), urinalysis, renal and bladder ultrasound, X-ray cystography, and video urodynamics.

As long-term sequelae of insufficiently treated neurogenic bladders (renal scarring, noncompliant fibrotic bladder) already have their origin in the first years of life, the frequency of multidisciplinary follow-up visits must be age dependent (3× yearly up to age 3 years, 2× yearly in school-aged children, yearly in adults). Typically, urinalysis and ultrasound are performed at all visits, cystography to investigate unexpected upper urinary tract infections, and urodynamics periodically to verify that under treatment, the catheterized bladder volumes are age appropriate [54] and stored under safe pressure conditions (storage of expected bladder capacity at pressures below 30 cm H_2O; see [55]).

With early instituted and optimal treatment, the large majority of patients can be adequately controlled without antireflux surgery or surgical bladder augmentation . Augmentation cystoplasty is limited to a small group of patients in whom medical treatment fails (persistence of high filling pressures). In patients with insufficient sphincter activity, continence achievement will require bladder-outlet surgery in addition to medical treatment.

In female wheelchair users, surgical intervention to provide a continent stoma will facilitate self-catheterization.

Long-term outcome evaluation and need for life-long follow-up

Lifelong follow-up with further periodic investigations of upper urinary tract changes, renal function, and bladder status is extremely important. There are two reasons why long-term outcome evaluation in adulthood and life-long patient follow-up are indispensable. First, for the individual patient, therapy is a life-long requisite, and verifying preservation of the patient's kidneys is only possible by repetitive assessment throughout adolescence and adulthood. Second, in general, detailed long-term follow-up data will show whether a treatment policy driven by long-term goals is sufficiently effective or requires further adaptations. The effectiveness of efforts preserving upper urinary tract function can only be judged by assessing the ultimate outcome once these patients have reached adolescence or adulthood [29]. In populations with NBSD, no consensus exists as to how renal status is ideally evaluated [56]. In clinical practice, upper urinary tract deterioration or protection is often monitored by radiographic images of hydronephrosis and vesicoureteral reflux. Modalities used to look at renal functions include nuclear imaging [dimercaptosuccinate acid (DMSA) renal scan], urinary concentrating ability, and glomerular filtration rate assessment. For the latter, creatinine (Cr) clearance can be used for patients who are socially continent; for others, inulin or Cr ethylenediaminetetraacetate (EDTA) clearance can be used. Which (combination) of these tests is best to evaluate renal function requires further investigation [56].

Materials and Methods:

This is a retrospective analysis of all children with neurogenic bladder admitted in Department of Paediatric Surgery, Christian Medical college ,Vellore during 2003 to 2008.The operative data and follow up data were collected from their hospital charts.

Patients: A total of 194 patients were admitted between January 2003 to December 2008 with neurogenic bladder. 131 patients came for follow up and their follow up data is available.

Mean follow up period was 3.08 years(Range 1year to 16 years).

Inclusion criteria:

All children with symptoms and signs of neurogenic bladder with proven cause.like Meningomyelocele (MMC),Anorectal malformations (ARM), Sacral Agenesis, Caudal Regression Syndrome.

Exclusion criteria : Children with neurogenic bladder secondary to trauma.

Methodology :

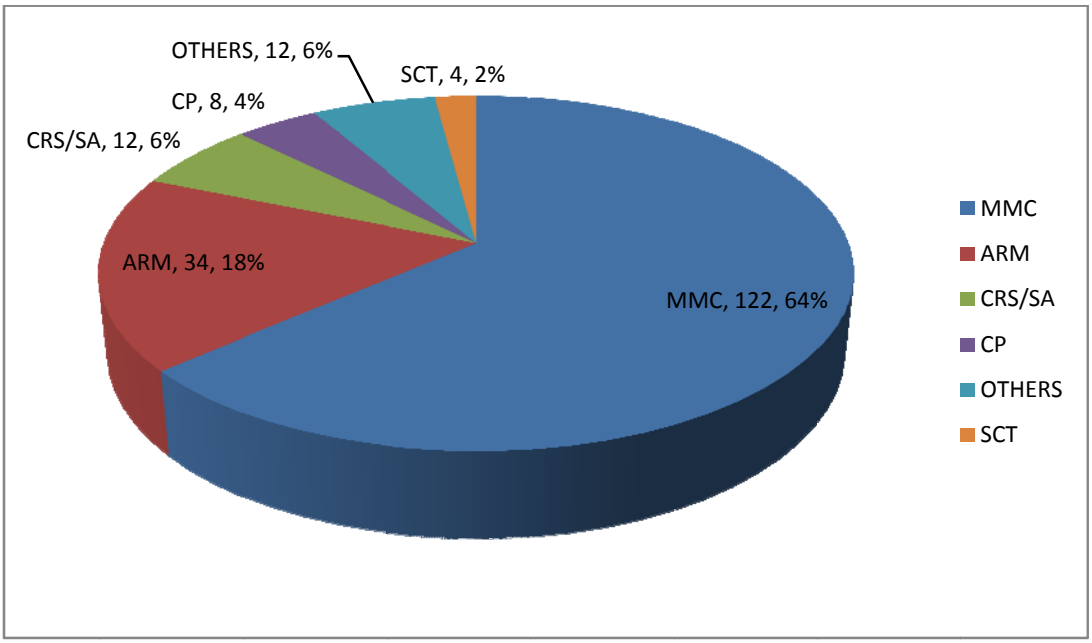
All children with diagnosis of neurogenic bladder were admitted in the ward and evaluated. Clinical examination and base line investigations like serum cratinine ,urine culture ,ultrasonogram and cystourethrogram was done.CMG and DMSA scaning was optional.As meningomyelocele was the most common cause of neurogenic bladder these children were analysed separately.

Case Material :

Etiology:

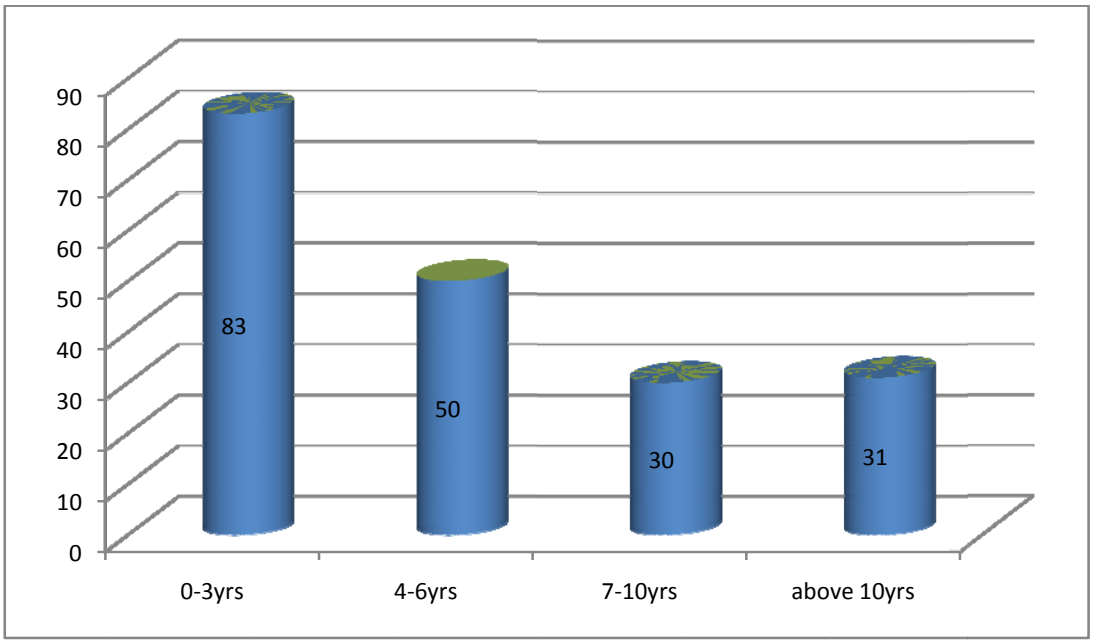
Meningomyelocele was the most common cause for neurogenic bladder seen in 122patients.ARM being next most common seen in 34 patients. 12 patients with sacral agenesis or caudal regression syndrome , other causes like cerebral palsy seen in 8 patients,Down's syndrome 2patients,sacrocoocygeal & retroperitoneal tumour in 4patients.In 12 patients cause was not known.These 12 children behaved like neurogenic bladder, as MRI was not part of our routine investigation tethered cord and spina bifida occulta cannot be excluded and they may also represent nonneurogenic neurogenic bladder ,hence they were included as part of study.

Etiology	**Number Of Patients**
Meningomyelocele	122 (63%)
ARM	34 (18%)
Sacral agenesis/Caudal Regression	12 (6%)
Cerebral Palsy	8 (4%)
Sacrococcygeal/retroperitoneal tumour	4 (2%)
Down's syndrome	2 (1%)
Others	12 (6%)
Total	194



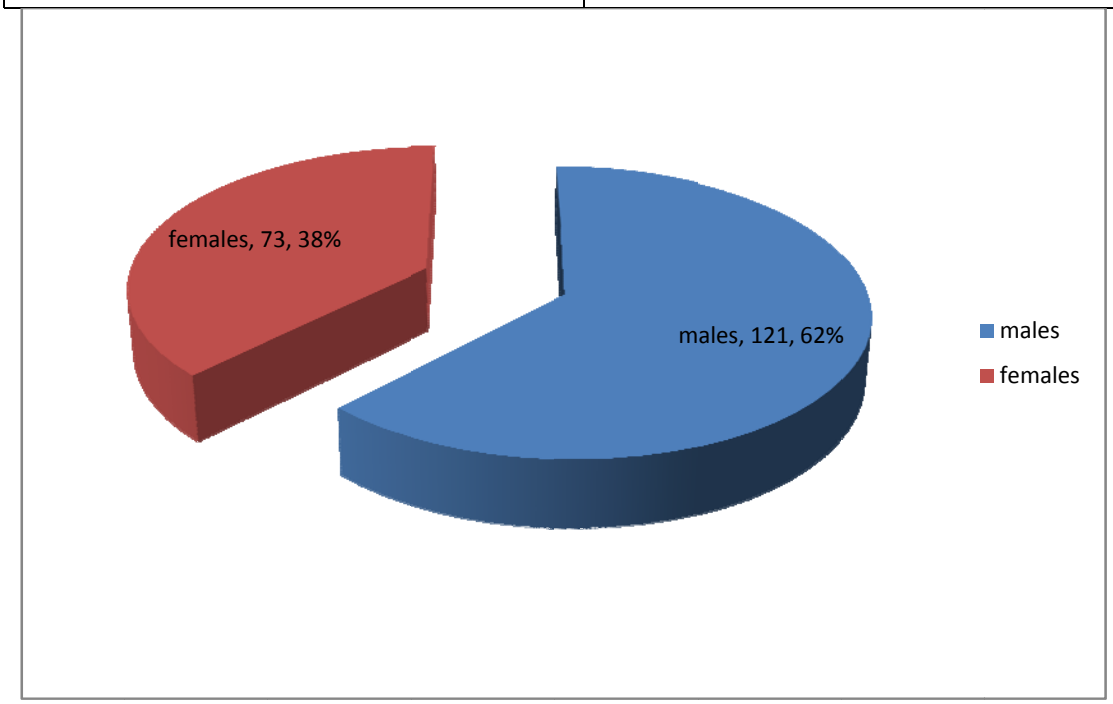
Age distribution:Children of various age group were treated for neurogenic bladder.Majority of children were below 6 years.Mean age at presentation was 5.27 years.

Age (years)	**Number of children (n=194)**
0-3	83 (42.7%)
4-6	50 (25.7%)
7-9	30 (15.4%)
Above 10	31 (15.9%)



Sex distribution:Of 194 patients 121 were males & 73 were females.

Males	121 (62.3%)
Females	73 (37.6%)



Serum Creatinine:Patients were grouped into two groups.Meningomyelocele (Group 1)& Other group (Group 2) based on primary etiology.

Group 1 : There were 122 patients .values were available for 118 patients ,in 4 patients values were not available.

Serum Creatinine (mg%)	Number of patients (n=118)
0-0.5	66 (55.9%)
0.6-1	40 (33.8%)
1.1-2	10 (8.4%)
Above 2	2 (1.5%)

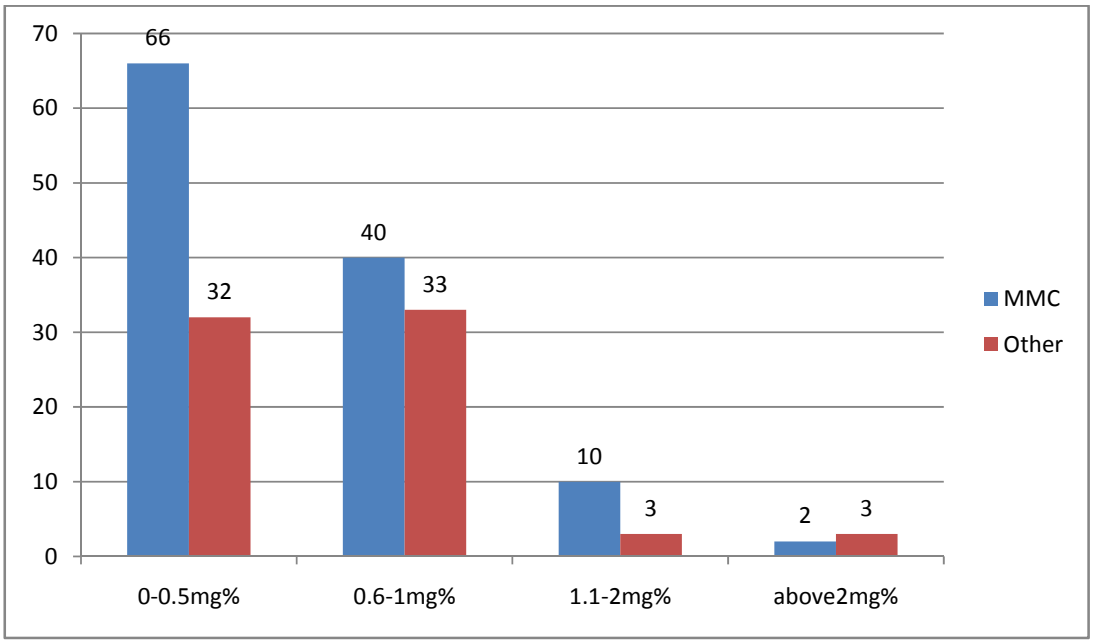
Mean - 0.65 mg% and standard deviation -0.371.

Group 2: There were 72 patients in other group.Values were available for 71 patients.

Serum Creatinine (mg%)	Number of patients (n=71)
0-0.5	32 (45%)
0.6-1	33 (46.4%)
1.1-2	3 (4.2%)
Above 2	3 (4.2%)

Mean -0.69 mg% and standard deviation - 0.43.

Most patients 89.7% in group1 and 91.4% in group2 patients presented with serum creatinine less than 1 mg%. 9.9% in group1 and 8.4% in group2 patients had their creatinine above 1mg%.


70
60
50
40
30
20
10
0
66
32
40
33
10
3
2
3
0-0.5mg%
0.6-1mg%
1.1-2mg%
above2mg%
MMC
Other

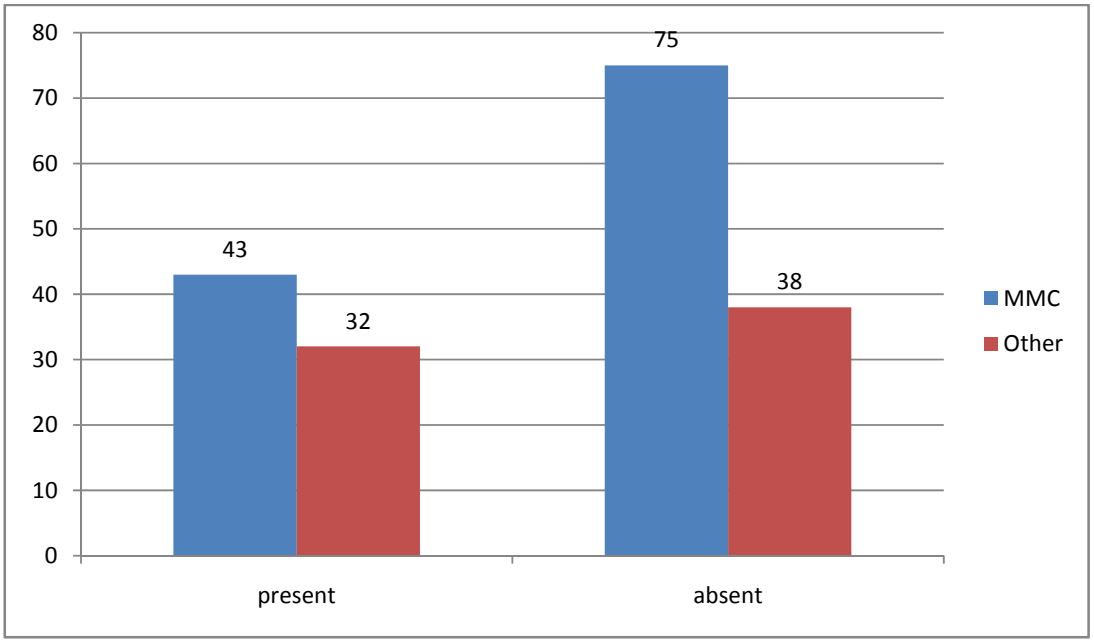
Urinary Tract Infection (UTI)

Presence of UTI was documented based on urine micro and culture report done prior to starting any therapy.Colony count more than one lac per ml was taken as significant.

UTI	Group 1 (n=118)	Group 2 (n=70)
Present	43 (36.4%)	32 (45.7%)
Absent	75 (63.6%)	38 (54.3%)

In group 1, 43 (36.4%) patients presented with UTI.

In group 2, 32 (45.7%) patients presented with UTI.



Upper Tract Changes:

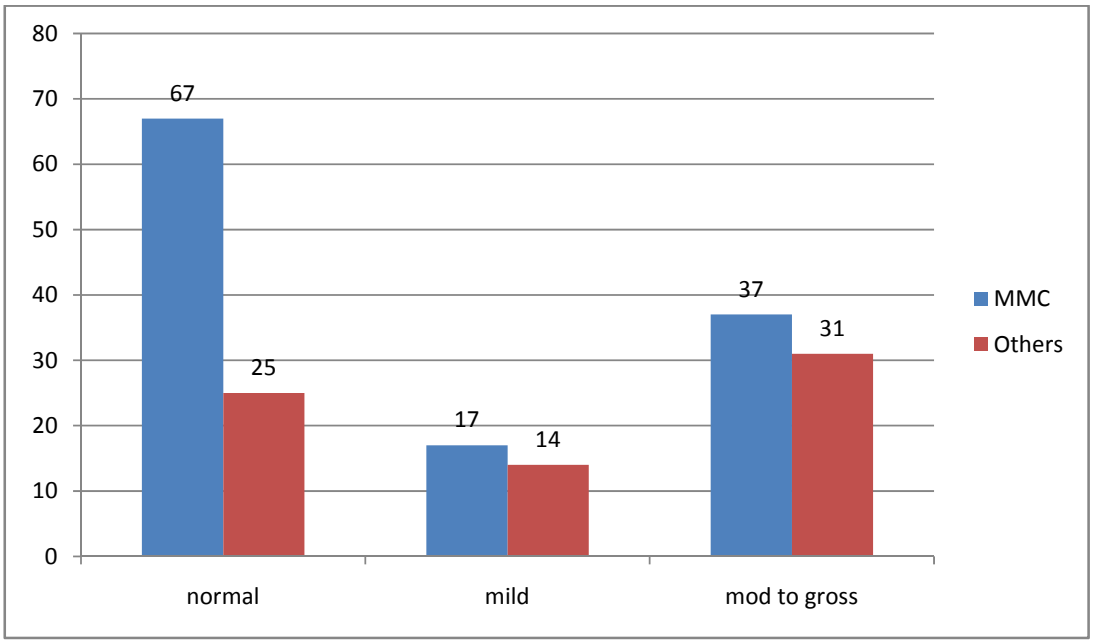
Group1 (MMC):Out of 122 patients ultrasound was available for 121 patients .For 1 patient ultrasound was not available.

Upper Tract Changes	Number of patients (121)
Normal	67 (55.4%)
Mild Hydro-Ureteronephrosis	17 (14%)
Moderate to Gross Hydro-Ureteronephrosis	37 (30.6%)

Group2: Of 72 patients ultrasound was available for 70patients.

Upper Tract Changes	Number of patients (70)
Normal	25 (35.7%)
Mild Hydro-Ureteronephrosis	14 (20%)
Moderate to Gross Hydro-Ureteronephrosis	31 (44.3%)

In group1, 67 (55.4%) of patients and 25 (35.7%) in group2 patients presented with normal preserved upper tracts.37 (30.6%) patients in group1 & 31 (44.3%) patients in group 2 presented with moderate to gross hydro-ureteronephrosis.



Cysto-Urethrogram :

Cysto urethogram was done to document bladder trabeculation and to know the status of reflux.

Group 1 (MMC): MCU was done in 114 children.For 8 children data was not available.

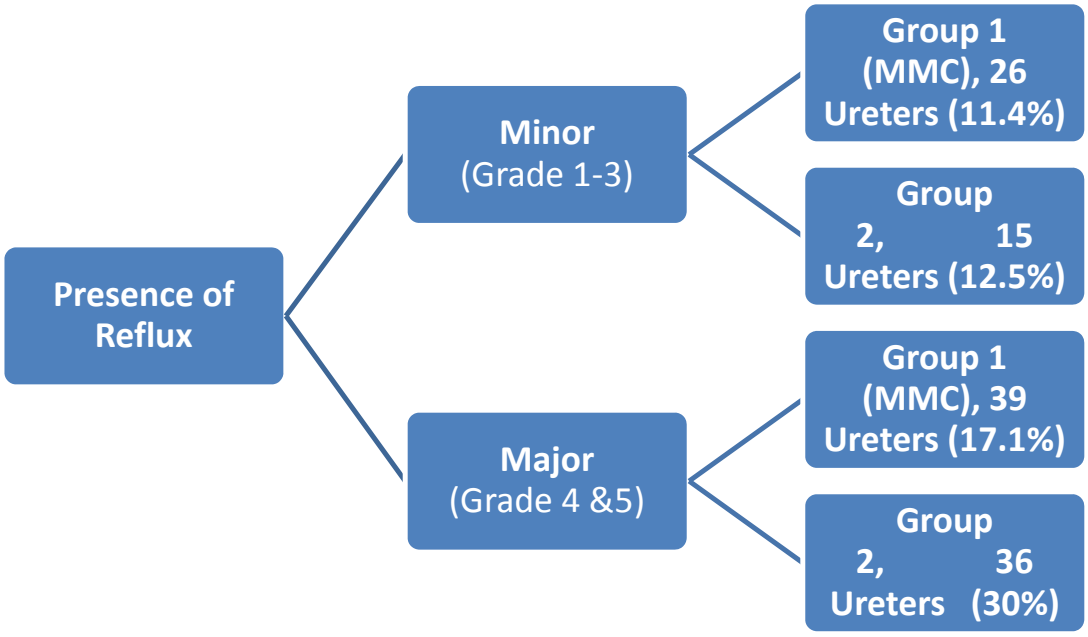
MCU	**Number of Children (n=114)**
Trabeculation Present	95 (83.4%)
Trabeculation Absent	19 (16.6%)

Group 2 : MCU was done in 60 children.For 12 children data was not available.

MCU	**Number of Children (n=60)**
Trabeculation Present	49 (81.7%)
Trabeculation Absent	11 (18.3%)

Vesico-Ureteric Reflux :

Presence of VUR was documented by cystourethrogram.Refluxing ureters were divided into two categories based on grade of reflux. Grade 1 to 3 was taken as minor while grade 4 & 5 were taken as major reflux. Overall there was 28.5% (65 ureters) refluxing ureters in group 1 and 42.5% (51 ureters) refluxing ureters in group2.

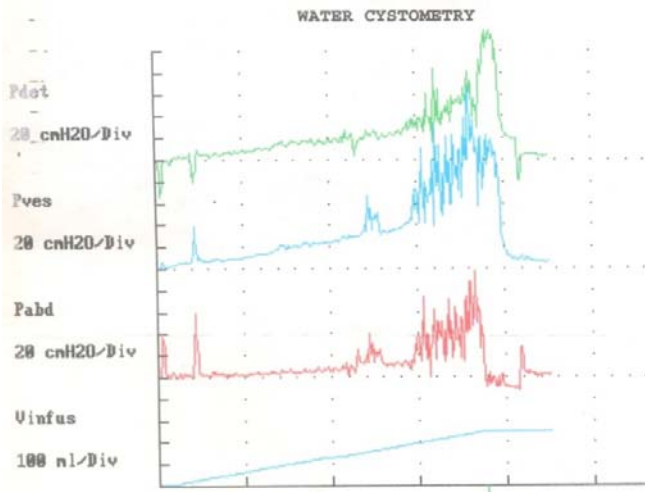


Urodynamic study :

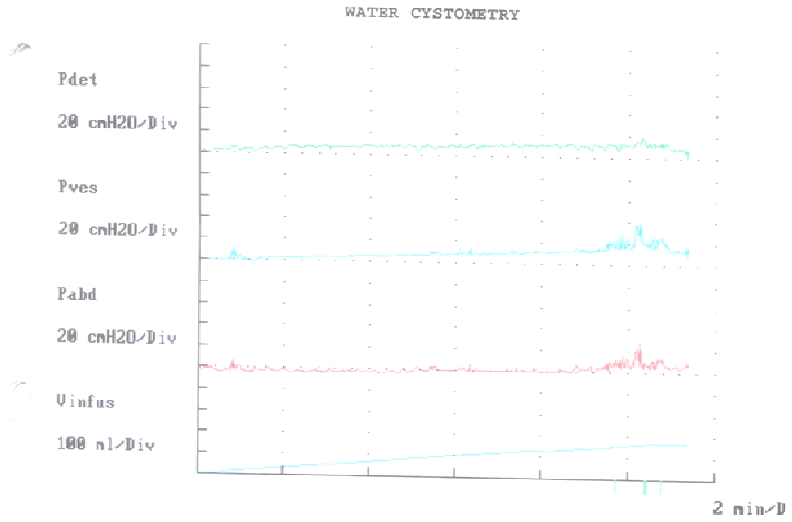
Urodynamic study was done in 60 children.Most common finding was poor compliance bladder with detrussor instability seen in 40 children.

Urodynamic study	**Number of Children (n=60)**
Poor Compliance with Detrussor Instablity	40
Poor Compliance without Detrussor Instablity	9
Moderate Compliance with Detrussor Instablity	2
Moderate Compliance without Detrussor Instablity	5
Good Compliance	4

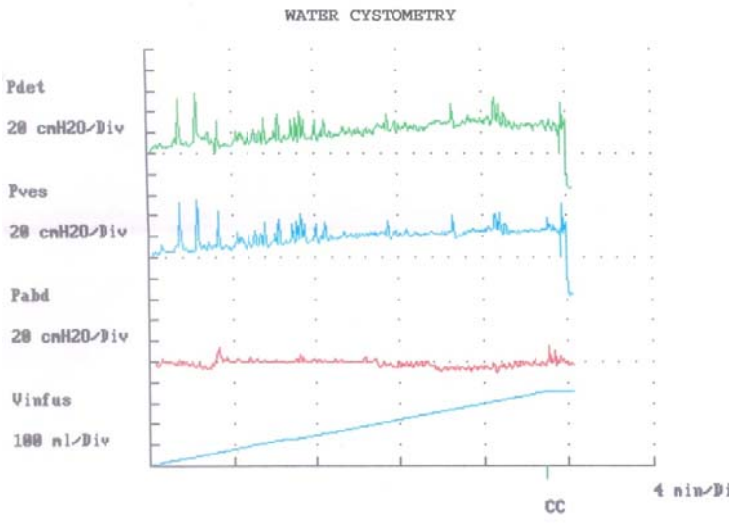
Poor Compliance with Detrussor Instablity (Before CIC)



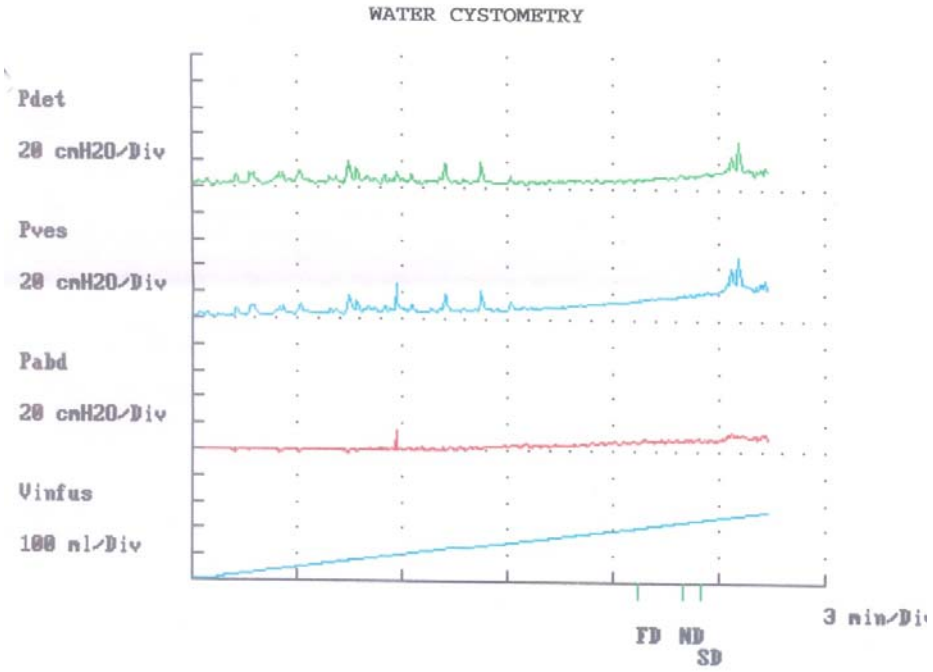
After CIC and Oxybutynin showing good compliance and quiet bladder



Poor Compliance with Detrussor Instablity (Before Augment)



Good compliant bladder (After Augmentation)



Upper tract changes and urodynamic correlation in these 60 children:

Ultrasound	Poor compliance with DI (n=40)	Poor compliance without DI (n=9)	Moderate compliance without DI (n=2)	Moderate compliance without DI (n=5)	Good compliance (n=4)
Normal	14	5	0	0	1
Mild HUN	6	0	1	3	0
Moderate HUN	16	3	1	1	1
Gross HUN	4	1	0	1	2

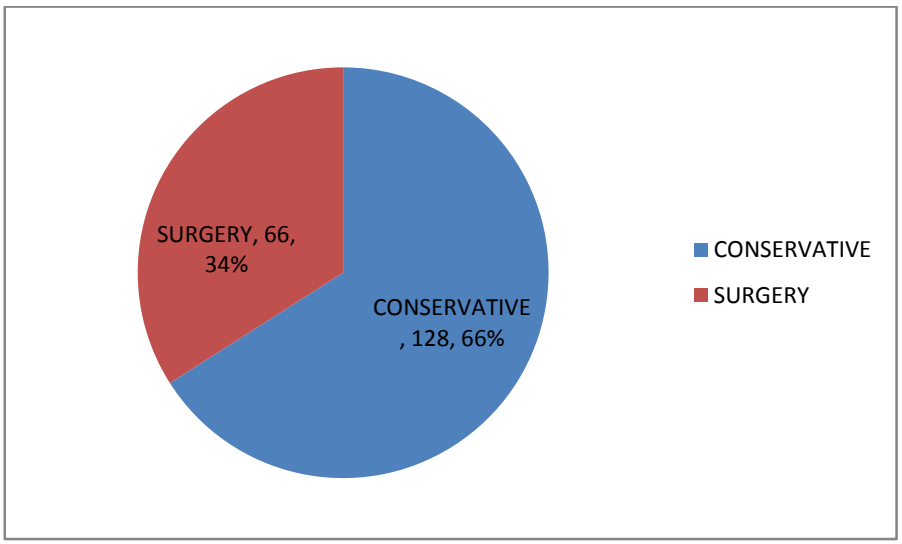
26 children with poor compliance and detrussor instability had uppertract changes and 14 children had normal upper tract.3 children with good compliance had moderate to gross hydronephrosis while only one child had no hydronephrosis this is because good compliance in urodynamic study in these children is due to presence of gross reflux .

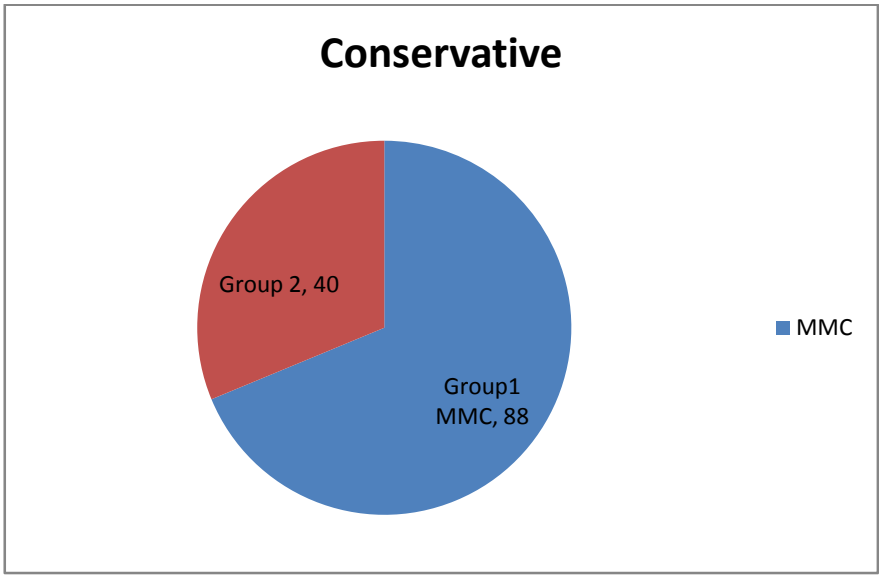
Management:

Patients were grouped into two groups based on their management.

Group A: Managed with CIC + Anticholenergic drugs (oxybutynin).

Group B: Patients requiring any surgical intervention.





CIC and Anticholenergic drug: A total of 128 (66%) patients out of 194 patients were managed with conservative line of CIC and drugs (oxybutynin).88 patients in meningomyelocele group and 40 patients in group 2.Patients or their parents were taught about CIC using number 6 or 8 infant feeding tube after admitting in ward.CIC was done by parents/patient after washing their hands every 3-4 hours in day time and night time bladder was left for continous drainage.Two special CIC bags made of cotton was provided to them.Each bag has multiple compartments to keep set of catheters that can be used for a day.In a single day patient uses catheter one after another present in the bag. After using the catheter it is washed and flushed with tap water and replaced back into the bag with cap of catheter left open to allow it to dry.Next day catheters present in the another bag are used while previous bag along with catheters was kept under sun to allow it to dry, to be used for next day.With this technique we have not encountered any urinary tract infection in children who are doing CIC. Oxybutynin was given in the dose of 0.3 to0.4 mg/kg in two divided doses. CIC was done either perurethrally in 123 children or through Mitrofanoff port done using appendix in 5 children.

Surgical Management: Indications for surgery

1.Patients with high serum creatinine.

2.Patients who have moderate to gross hydro-ureteronephrosis.

3.Patients with gross vesico-ureteric reflux in MCU.

Types of surgery done are:

1.Augmentation Cystoplasty – Most common.

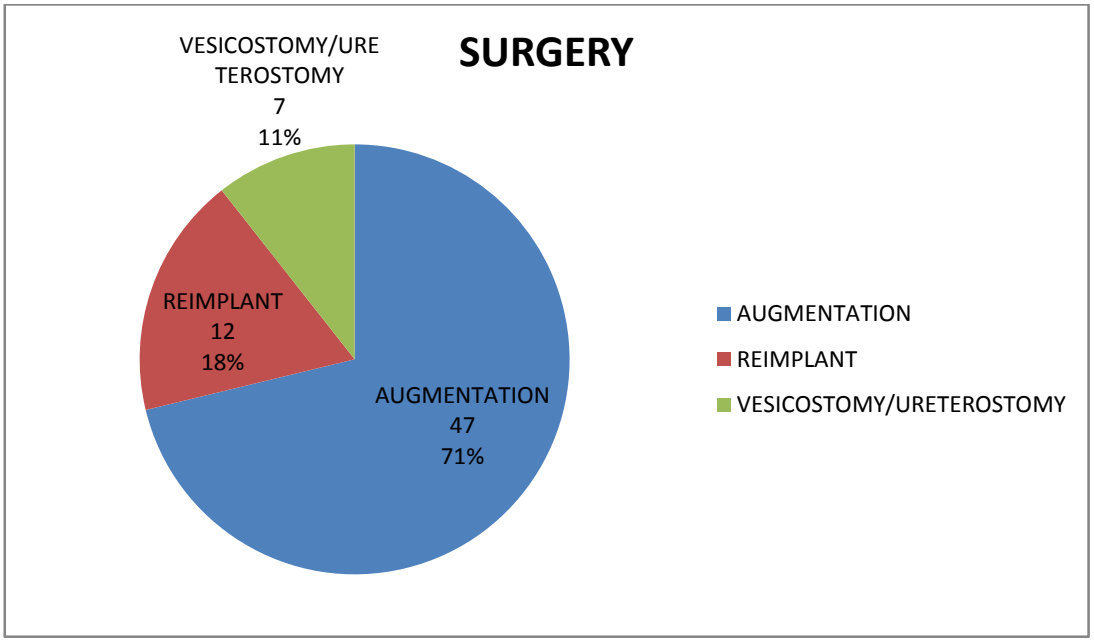
2.Ureteric Reimplantation with Appendicular Mitrofanoff.

3.Vesicostomy or Ureterostomy.

4.Bladder Neck Procedure.

A total of 66 (34%) patients underwent surgical management.

Surgery	MMC group 1	group 2	Total (n=66)
Augmentation cystoplasty +/- Reimplant	29	18	47
Ureteric Reimplant + Appendicular Mitrofanoff	3	9	12
Vesicostomy /Ureterostomy	2	5	7



Results

Results of followed patients:

A total of 194 childrens with neurogenic bladder were managed during 2003 to 2008 at CMC Vellore.Children were grouped into two categories based on their management .One group consisted of children managed with conservative line and other group constituted children managed with surgery.A total of 128 (65.9%) children were managed conservatively, only 76 children came for follow up.A total of 66 children were managed by surgery and 57 children came for follow up.

Most common etiology being meningomyelocele constituting 122 (62.8%) childrens.

Male to female ratio about 1.65.

Mean follow up period was about 3.08 years (range 1 year to 16 years).

Most patients presented with serum creatinine less than 1mg%,only 18 children (1%)presented with serum creatinine above 1 mg%.

92 (48.1%) patients presented with normal preserved upper tracts and 68(35%) of patients presented with moderate to gross hydro-ureteronephrosis.31(16%) patients had mild hydronephrosis.

There were total of 116 (33.3%) refluxing ureters.Of which 41(11.8%) were minor refluxing ureters and 75 (21.5%) were major refluxing ureters.

Bladder trabeculation in cystourethrogram was found in 144 (82.7%) children.

Factors analysed in followed up children

1.Conservative (medical) management:patients were managed with CIC and oxybutynin.

A total of 128 (65.9%) patents were managed with CIC & oxybutynin.88 patients in MMC group and 40 patients in other group.Only 76 patients came for follow up.52 children in MMC group and 24 children in other group.7 children were irregular in their CIC who were readmitted and importance of CIC was reinforced.69 children were regular and compliant in their CIC and were dry in between CIC.

A.Serum Creatinine:

Group 1 (MMC):52 children came for follow up.Values was not available for 4 children.

Serum Creatinine(mg%)	At presentation (n=48)	Followup (n=48)
0-0.5	38	34
0.6-1	8	13
1.1-2	1	0
above 2	1	1
	Mean - 0.55 mg%	Mean - 0.57 mg%
	Standard deviation -0.326	Standard deviation -0.318

46 children had their serum creatinine value less than 1 mg% before starting CIC.Only one child had value above 2mg%.At follow up 47 patients remained with serum creatinine less than 1mg%,except one child whose creatinine remained at above 2mg%.

Group 2 :24 children came for follow up.Values was not available for 3 children.

Serum Creatinine(mg%)	At presentation (n=21)	Followup (n=21)
0-0.5	15	10
0.6-1	5	10
1.1-2	1	1
above 2	0	0
	Mean - 0.51 mg%	Mean - 0.58 mg%
	Standard deviation -0.185	Standard deviation -0.179

20 children had their values below 1mg%.At follow up 20 children values remained below 1mg%.

B: Upper Tract Changes:

Group 1 (MMC): Of 52 children ultrasound was not available for 3 children.

Ultrasound	At presentation (n=49)	Follow up (n=49)
Normal	35	36
Mild Hydro-Ureteronephrosis	8	9
Moderate Hydro-Ureteronephrosis	6	4
Gross Hydro-Ureteronephrosis	0	0

35 chidren had normal upper tract before starting treatment.14 chldren had evidence of mild to moderate hydronephrosis before treatment.At follow up most children remained either with normal upper tracts or mild to moderate hydronephrosis with improvement compared to their presentation ultrasound. Only 2 children had increase in degree of hydronephrosis compared to their previous scan.One child had increase from normal to moderate degree, this child also had discontinued CIC for some time.Other child had increase from moderate degree.

Group 2 : Of 24 children follow up ultrasound was not available in 1 child.

Ultrasound	At presentation (n=23)	Follow up (n=23)
Normal	14	13
Mild Hydro-Ureteronephrosis	6	10
Moderate Hydro-Ureteronephrosis	3	0
Gross Hydro-Ureteronephrosis	0	0

14 children had normal upper tract before starting treatment and 9 children had evidence of mild to moderate hydronephrosis before treatment.At follow up most children remained either with normal upper tracts or mild hydronephrosis with improvement compared to their presentation ultrasound. Only 2 children had increase in degree of hydronephrosis from normal to mild degree compared to their previous scan.

Association of UTI in children with reflux managed by CIC :

A total of 31 children with reflux were managed with CIC .21 children with minor reflux and 10 children with major reflux.15 children came for follow up.

Recurrent UTI	Children wih minor reflux (n=10)	Children wih major reflux (n=5)
Present	2	3
Absent	8	2

3 out of 5 children with major reflux managed with CIC were getting recurrent UTI.While only 2 out of 10 children with mnor reflux were getting recurrent UTI.

2. Surgery :

A total of 66 (34.1%) patients underwent surgical procedure for management of neurogenic bladder. Most common surgery was augmentation cystoplasty using bowel done in 47 patients ,Ureteric reimplant with appendicular Mitrofanoff done in 12 patients,Vesicostomy or Ureterostomy done in 7 patients.

A.Augmentation cystoplasty:

This was the most common surgery done in 47 children.29 children in MMC group and 18 children in group 2.Most common segment of bowel used for augmentation was sigmoid colon done in 33 children other segments used were ileum ,ileo-caecal and uretero cystoplasty. 38 children came for follow up.

Type of tissue used for augment	Number of Children (n=47)
Sigmoid colon	33
Ileum	7
Ileo-caecal segment	4
Ureterocystoplasty	3

Factors analysed in augmented children:

1.Serum Creatinine:

Group1 (MMC):23 children came for follow up.

Serum Creatinine(mg%)	At presentation (n=23)	Followup (n=23)
0-0.5	5	7
0.6-1	9	13
1.1-2	7	3
above 2	2	0
	Mean - 0.91 mg%	Mean - 0.74 mg%
	Standard deviation -0.564	Standard deviation -0.282

14 children had their value less than 1 mg% before starting surgery. 7 children had value above 1mg% before surgery and 2 children had value above 2mg%.At follow up 20 children remained with serum creatinine less than 1mg%,only 3 children had value above 1mg%.

Group 2 :16 children came for follow up.

Serum Creatinine(mg%)	At presentation (n=16)	Followup (n=16)
0-0.5	3	1
0.6-1	11	10
1.1-2	2	4
above 2	0	1
	Mean - 0.82 mg%	Mean - 0.93 mg%
	Standard deviation -0.365	Standard deviation -0.457

14 children had their value less than 1 mg% before starting surgery. 2 children had value above 1mg% before surgery.At follow up most patients 11 children remained with serum creatinine less than 1mg%,only 1 child had value above 2mg%.There was increase in serum creatinine in 3 children.

2.Upper Tract Changes:

Group 1 (MMC): 23 children came for follow up.

Ultrasound	At presentation (n=23)	Follow up (n=23)
Normal	6	11
Mild	2	7
Moderate	11	5
Gross	4	0

17 children had evidence of upper tract changes before surgery and 15 children had moderate to gross hydroureteronephrosis.At follow up most patients had improvement in degree of hydronephrosis.only 5 patients had moderate hydronephrosis.

Group 2 : 16 children came for follow up.

Ultrasound	At presentation (n=16)	Follow up (n=16)
Normal	1	5
Mild	1	4
Moderate	11	6
Gross	3	1

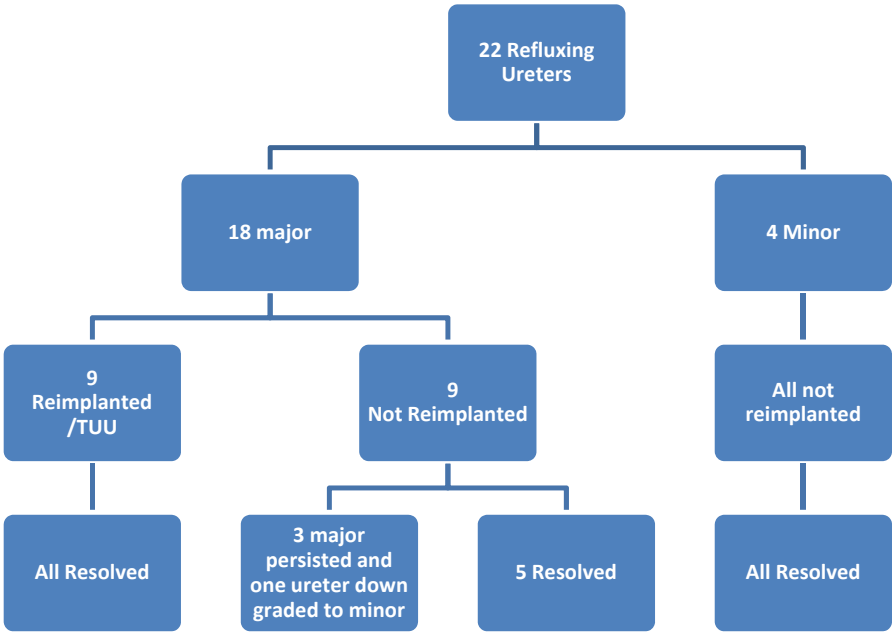
15 children,had evidence of upper tract changes before surgery.At follow up most patients had improvement in degree of hydronephrosis.only 6 patients had moderate hydronephrosis and only one child had gross hydronephrosis.

3.Vesico-Ureteric Reflux:

Presence of VUR in MCU was divided into minor (grade1-3) and major (grde 4-5).Minor refluxing ureters were left alone at the time of operation while major refluxing ureters were either reimplanted or tackled by transuretero-ureterostomy (TUU) to non refluxing ureter.

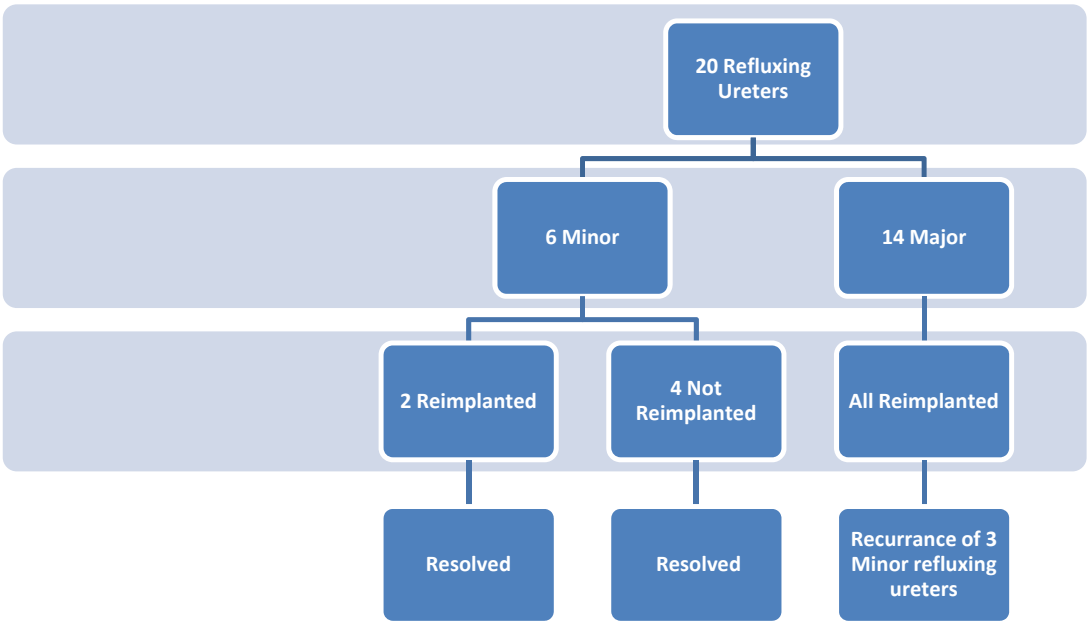
Group 1 (MMC): There were 22 refluxing (4minor+18major) ureters before surgery.Of 18 major refluxing ureters, 9 ureters were reimplanted and 9 ureters were not reimplanted.All minor refluxing 4 ureters were not reimplanted.After surgery only 4(1minor + 3major) persisted which were not reimplated before.one was tackled by TUU while other child (2units) is waiting for surgery.

VUR	Before surgery	After surgery
Minor	4	1
Major	18	3



Group 2 : There were 20 refluxing (6minor+14major) ureters before surgery. All 14 major refluxing ureters were reimplanted.In minor 6 refluxing ureters , 2 were reimplanted and 4 were not reimplanted.After surgery there was recurrence of 3 minor refluxing ureters which were major refluxing ureters before and all were reimplanted during surgery.

VUR	Before surgery	After surgery
Minor	6	3
Major	14	0



B : Other procedures done are

1. Reimplant alone with Appendicular Mitrofanoff :

12 children underwent ureteric reimplantation and appendicular Mitrofanoff procedure for major reflux .3 children in group 1 (MMC) and 9 children in group 2.Total 11 children came for follow up.

a: Serum creatinine :

Serum Creatinine(mg%)	At presentation (n=11)	Followup (n=11)
0-0.5	4	2
0.6-1	7	9
	Mean – 0.61 mg%	Mean - 0.65 mg%
	Standard deviation -0.137	Standard deviation -0.121

All 11 children presented with serum creatinine less than 1 mg % .At follow up all 11 children remained with serum creatinine less than 1 mg%.

b: Ultrasound :

Ultrasound	At presentation (n=11)	Follow up (n=11)
Normal	1	3
Mild	7	7
Moderate	1	0
Gross	2	1

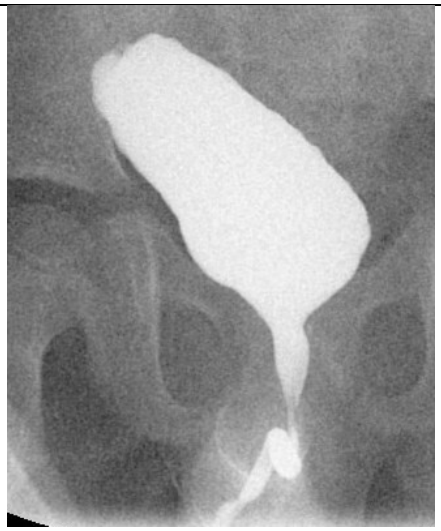
At presentation 7 children had mild hydronephrosis ,1 child moderate hydronephrosis and 2 children had gross hydronephrosis.At follow up there was improvement in degree of hydronephrosis in most children only one child remained with gross hydronephrosis.

2. 5 children underwent vesicostomy and 2 children underwent ureterostomy,due to high serum cretinine and gross hydro-ureteronephrosis and children were very young .They are planned for definitive surgery in later years.

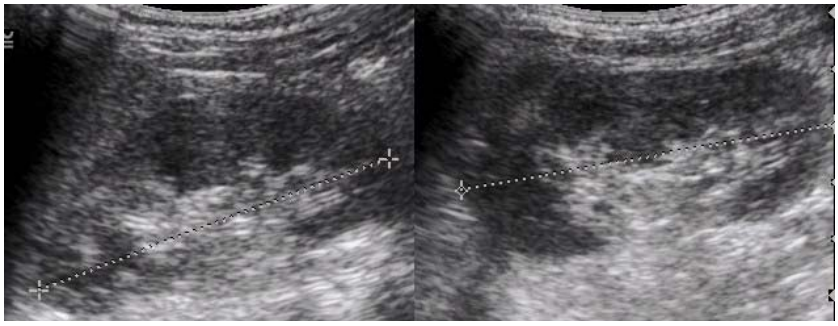
Illustrative Cases

Case1 : Child with normal upper tracts and no reflux : Managed with CIC and oxybutynin

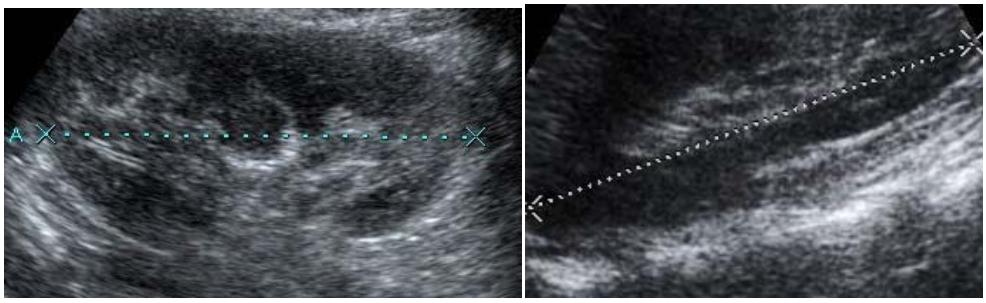
MCU Showing trabeculated and elongated bladder ,No Reflux



Ultrasound showing normal uppertracts

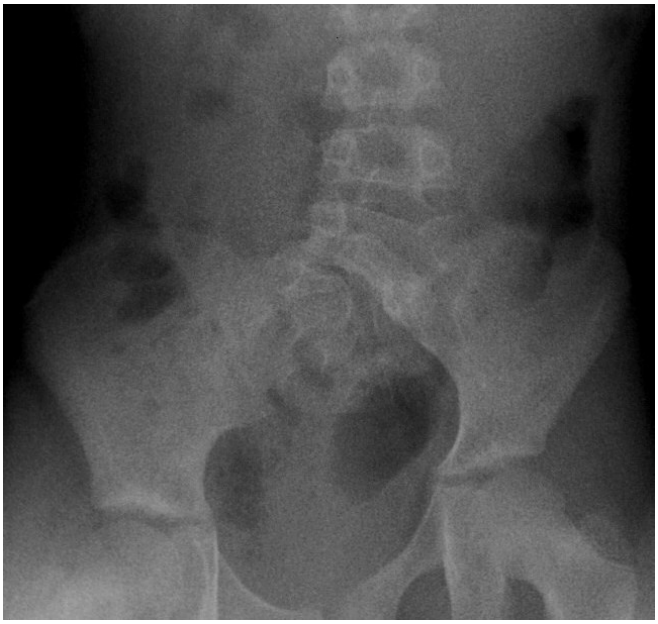


Followup ultrasound showing preserved upper tracts

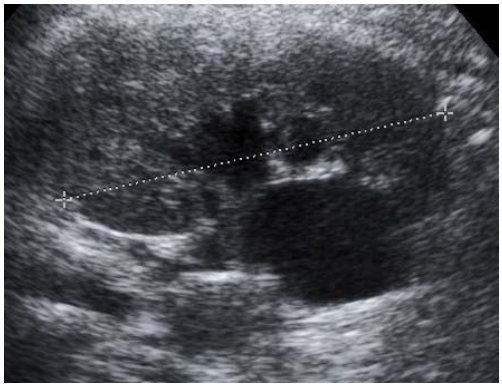


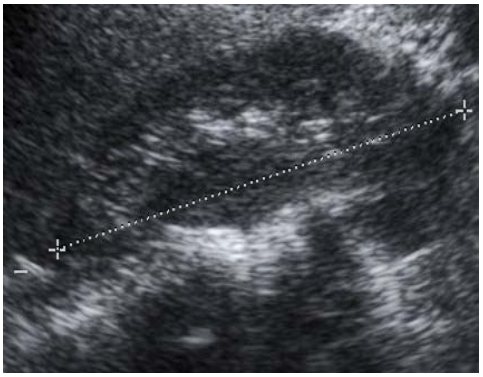
Case 2: Child with ARM and sacral agenesis managed by augmentation cystoplasty.

Sacral deficiency

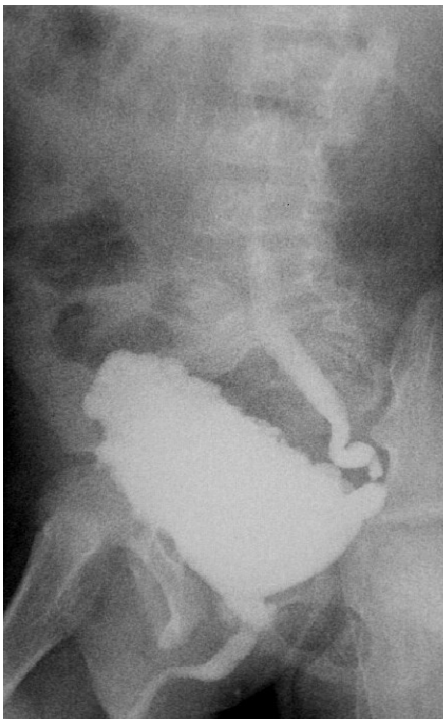


Ultrasound showing hydronephrotic kidneys

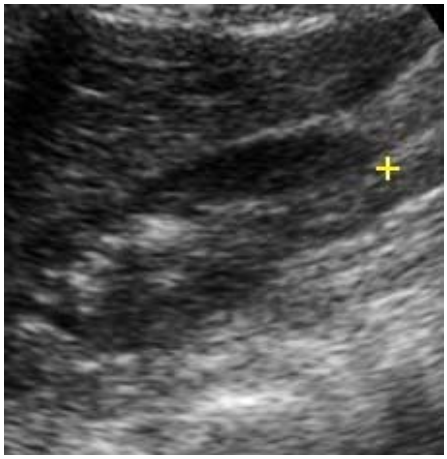


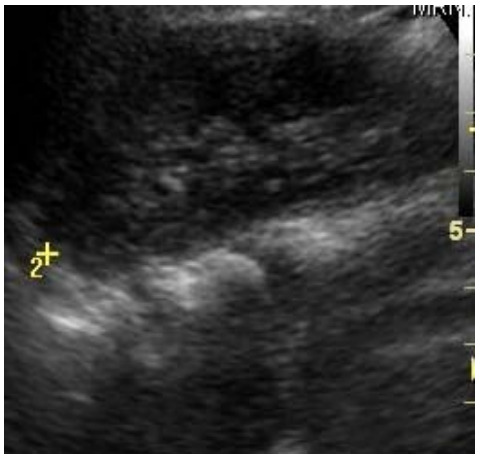


MCU showing reflux and trabeculated bladder



After augmentation improvement in hydronephrosis

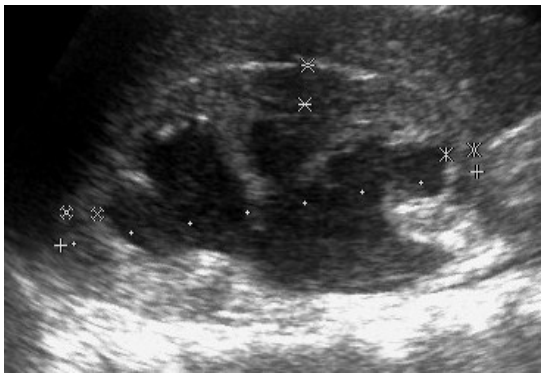


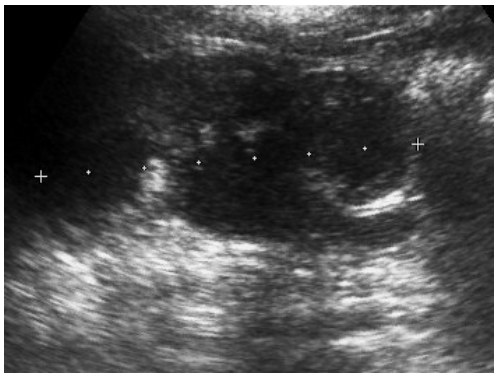


MCU showing resolution of reflux

Case 3 : Child with Down's syndrome and neurogenic bladder managed by vesicostomy.

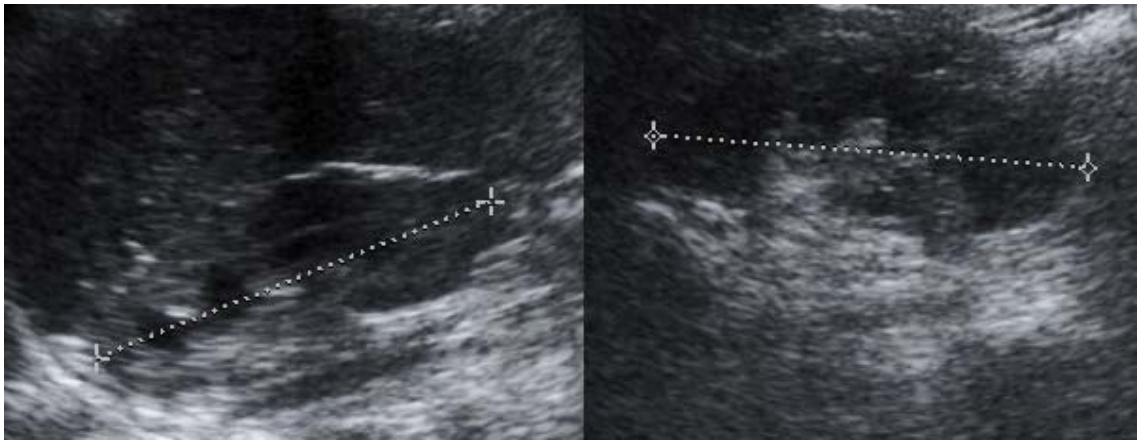
Ultrasound showing hydronephrotic kidneys





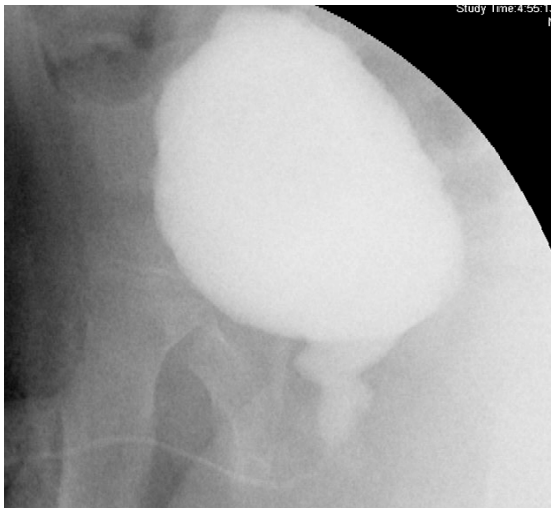
MCU showing gross reflux and trabeculated bladder

Follow up ultrasound showing resolution of hydronephrosis after Vesicostomy

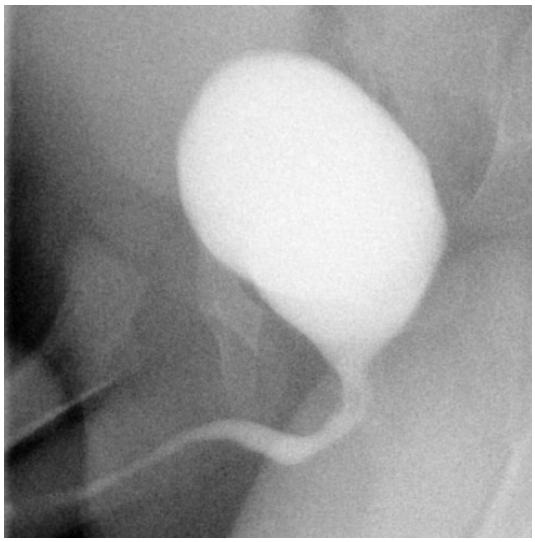


Follow up MCU done through Vesicostomy site showing resolution of reflux

Case 4: MCU showing dilated posterior urethra in a case of neurogenic bladder



Case 5 : Child with neurogenic bladder without trabeculation in MCU managed by CIC



Operated Case of MMC , Mother doing Perurethral CIC

Girl with Spina bifida occulta with tuft of hair on back

Girl doing CIC on her own via Mitrofanoff port after augmentation

A special CIC bag with multiple compartments for catheters

Girl with neurogenic bladder undergoing urodynamic study

Discussion

Neurogenic bladder in children is one of most preventable cause of chronic renal failure if managed at proper time.Because these children are born with normal preserved upper tracts unlike other causes of chronic renal failure in children like posterior urethral valve where there will be associated renal dysplasia..Our study was a retrospective study of children with neurogenic bladder managed during 2003 to 2008.

A total of 194 children were managed during this period.

Most common etiology was meningomyelocele seen in 122 (62.8%) children.

Disease was slightly male predominance with 121(62.3%) children being boys.

Children of various age groups were treated .Most children 133(68.4%) were below 6 years of age.

Children were grouped into two groups based on their etiology.As MMC was most common cause these children were analysed separately and other group constituted other children with various causes.

CIC with anticholinergics (oxybutynin) is effective and first line of treatment in managing neurogenic bladder in children irrespective of etiology. In our study we managed 128 (66%)Children conservatively with CIC and drugs.Most of our patients were from poor socio economic background and we have adopted cheap and economic way of instituting CIC. Two special CIC bags made of cotton was provided to them.Each bag has multiple compartments to keep set of catheters that can be used for a day.In a single day patient uses catheter one after another present in the bag. After using the catheter it is washed and flushed with tap water and replaced back into the bag with cap of catheter left open to allow it to dry.Next day catheters present in the another bag are used while previous bag along with catheters was kept under sun to allow it to dry, to be used for next day.With this technique we have not encountered any urinary tract infection in children who are doing CIC.

In our study 76 children managed with CIC and oxybutynin came for follow up .usually our protocol for managing children with CIC are a)children not in renal failure, b) no evidence of gross hydro-ureteronephrosis on imaging C) no evidence of gross reflux documented in cystourethrogram.

On follow up 67 children serum creatine remained below 1 mg%.2 children remained above 1mg% but they had high serum creatinine before starting CIC.

Follow up ultrasound showed most children either remained stable or improvement in degree of hydronephrosis .only 4 children had increase in degree of hydronephrosis compared to their previous scan.

8 out of 10 children with minor reflux didnot get recurrent UTI while 3 out 5 children with major reflux were getting recurrent UTI.Children with minor reflux without uppertract changes can be managed with CIC alone.While children with major reflux and gross upper tract changes should be managed with surgery.

Clean intermittent catheterization (CIC) or self-catheterization (CISC) in combination with anticholinergics (oxybutynin) is the standard therapy for children with neurogenic bladder dysfunction with detrusor hyperactivity and/or DSD [11, 15, 16]. This treatment is also feasible and effective in developing countries, where untreated neuropathic bladder is an important cause of preventable chronic renal failure [17, 18]. CIC enables complete bladder emptying and thus avoids bladder residues and consequent risks for infections. In the high-risk bladder with DSD, CIC also allows bladder emptying before the occurrence of otherwise "spontaneous" high-pressure voiding, which is known to be detrimental for kidney function and drainage. Oxybutynin, a bladder smooth-muscle relaxant, is used to improve bladder dynamics through suppression of detrusor hypertonicity and hyperreflexia. By doing so,

oxybutynin eliminates (high-pressure) uninhibited detrusor contractions (and thus urinary leakage) and prevents high-pressure bladder storage (due to detrusor hypertonicity)

At birth, the majority of patients with neurogenic bladder has normal upper urinary tracts. Without proper management, urinary tract infections and elevated bladder pressures with secondary bladder-wall changes may cause upper urinary tract deterioration within 3 years in up to 58% [5]. One third of children who develop impaired kidney drainage do so within the first year of life [19]. The specific abnormalities vary considerably and are not predicted by the level of the spinal cord defect. Furthermore, the dysfunctional pattern may be dynamic, influenced by spinal cord surgery, tethering, and denervation.

In our study 66 (34.1%) patients underwent surgical procedure for management of neurogenic bladder.Most common surgery was augmentation cystoplasty done in 47 children.Other surgeries being ureteric reimplantation with appendicular Mitrofanoff done in 12 patients and ureterostomy/vesicostomy done in 5 patients.Our indications for surgery are a)patients with high serum creatinine at presentation b) evidence of moderate to gross hydroureteronephrosis in ultrasound imaging c) evidence of major reflux in cystourethrogram.

In augmented MMC group, 9 children had serum creatinine above 1 mg% before surgery ,at follow up only 3 children remained above 1mg%.while in group 2 , 2 children had serum creatinine above 1 mg% before surgery ,at follow up 5 children were above 1mg%.3 children had worsening of their serum creatinine in this group.

In augmented MMC group, 15 children had moderate to gross hydronephrosis before surgery ,at mean follow up after 3.5 years only 5 children had moderate to gross hydronephrosis .while in other group , 14 children had moderate to gross hydronephrosis before surgery ,at follow up 7 children had moderate to gross hydronephrosis.There was significant improvement in the degree of hydronephrosis in augmented patients. By augmentation some time serum creatinine may not

improve but definitively degree of hydroureteronephrosis comes down.Augmentation cystoplasty is effective in preserving upper tract deterioration as it converts high pressure storage system into low pressure storage reservoir .Augmentation alone is also effective in abolishing minor refluxes by decreasing high intravesical pressure.

CONCLUSION:

Medical management with CIC and anticholinergics is effective in preserving renal function and providing safe urinary continence in more than 90% of patients with a neurogenic bladder. Early diagnosis and treatment institution, long before continence becomes an issue at toddler age, can prevent both renal damage and secondary bladder-wall changes, thereby improving long-term outcomes. Augmentation cystoplasty is indicated where conservative line of management has failed.

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Abbreviation :

NBSD	neurogenic bladder sphincter dysfunction
MMC	Myelomeningocele
CIC	clean intermittent catheterization
CISC	clean intermittent self-catheterization
DSD	detrusor sphincter dyssynergia
HUN	hydrouretero nephrosis
ARM	Anorectal Malformation
SA	Sacral Agenesis
CRS	Caudal Regression Syndrome
CP	Cerebral Palsy
SCT	Sacrococcygeal Tumour

Key to Master Chart:

Age1	Age at presentation
Age2	Age at last Follow up
Creat1	Creatinine at presentation
Creat1	Creatinine at follow up
Usg1	Ultrasound at presentation
Usg2	Ultrasound at follow up
MCU1	Cystourethrogram at presentation
MCU2	Cystourethrogram at follow up
UTI	Urinary Tract Infection
C+O	CIC + Oxybutynin
Aug	Augmentation cystoplasty
Appen Mitro	Appendicular Mitrofanoff
TUU	Trans Ureteroureterostomy
P	Present
A	Absent
MMC	Meningo myelocele
ARM	Anorectal Malformation
SA	Sacral Agenesis
CRS	Caudal Regression Syndrome
CP	Cerebral Palsy
SCT	Sacrococcygeal Tumour
NNNB	Nonneurogenic neurogenic bladder

Name	Hosp No	Age 1	Age 2	Sex	UTI	crea1	crea2	USG 1	USG 2	MCU 1	MCU2	Treatment	F/U (yrs)	Etiology
Sakiya	352042c	6	9	F	P	0.5	0.6	N	N	Nil	-	C+O	3	MMC
Goutham	330958c	1	-	M	A	-	-	N	-	L I	-	C+O	-	MMC
Gokul Raj	300290c	6	-	M	P	0.5	-	N	-	L I	-	C+O	-	MMC
Suguna' B	094822C	2	4	F	P	0.9	0.7	B/L mild	B/L mild	R IV, L I	-	C+O	2	MMC
Amit Dey	488585C	12	-	M	A	0.7	-	B/L gross	-	L V	-	Aug	-	MMC
Blesson	398717C	4	-	M	A	0.5	-	-	-	B/L V	-	Aug	-	MMC
Chintu P	509926C	13	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
G. Begum's B	652058B	6	11	M	A	0.5	0.5	B/L mild	N	Nil	-	C+O	5	MMC
Jitendra Shaw	439332C	14	-	M	A	0.8	-	N	-	L I	-	C+O	-	MMC
Malathi	505178C	3	-	F	A	0.4	-	N	-	Nil	-	C+O	-	MMC
Nithin	461777C	3	8	M	P	0.5	0.5	N	N	Nil	-	C+O	5	MMC
Nandalal	535507C	9	15	M	A	0.5	0,5	N	N	Nil	-	C+O	6	MMC
Palani	385938A	14	20	M	A	1.1	1	N	N	Nil	-	Aug	6	MMC
Puja Barui	529044C	5	6	F	A	1.3	1.1	B/L mod	B/L mild	L V	Nil	Aug, L →R TUU	1	MMC
Prabavathi's B	235725C	2	8	M	A	0.6	0.7	N	N	R III, L I	Nil	Aug+ BND	6	MMC
Rangasusma	460647C	4	8	F	P	0.5	0.6	B/L mild	B/L mild	Nil	-	Aug	4	MMC
Srinivasan	457827C	14	15	M	A	0.7	0.9	N	-	Nil	-	C+O	1	MMC
Syam Prakash	459487C	4	7	M	P	0.4	0.5	B/L mild	N	R V, L II	Nil	Aug	3	MMC
Sophia	51979C	2	4	F	A	1.1	0.6	L mod	L mild	L IV	Nil	Aug+L reimplant	2	MMC
Saptharishi	522954B	7	-	M	A	0.6	-	N	-	Nil	-	C+O	-	MMC
Suguna' B	094822C	3	4	F	P	0.7	0.7	B/L mild	B/L mild	R IV, L I	-	Aug	1	MMC
Sahaya Ruben	415226C	11	15	M	A	0.7	0.9	B/L mod	B/L mod	R III, LV	Nil	Aug+ B/L reimpl	4	MMC
Vishnupriya	466059C	8	-	F	A	0.4	-	N	-	Nil	-	C+O	-	MMC
Velumurugan	833388B	5	9	M	A	0.5	0.6	N	N	Nil	-	C+O	4	MMC
W Mubaraq	573511C	6	8	M	P	0.5	0.5	N	N	Nil	-	C+O	2	MMC
Anubhav Kumar	611260C	9	14	M	A	0.5	0.7	N	N	Nil	Nil	C+O	5	MMC
Chiku Kumar	736649C	4	-	M	A	0.5	-	N	-	R IV	-	C+O	-	MMC
Dirija Anirudh	713786C	6	-	M	P	0.6	-	N	-	Nil	-	C+O	-	MMC
Githa's B	589608C	2	5	M	A	0.4	0.5	N	N	Nil	-	C+O	3	MMC
Harthi	019866B	3	17	F	P	0.7	0.8	B/L mild	N	B/L IV	Nil	B/L reimplant	14	MMC
Jyothi Singh	694877C	1	-	F	A	-	-	L mod	-	Nil	-	C+O	-	MMC
Kavitha's B	319860C	1	-	M	A	-	-	N	-	-	-	C+O	-	MMC
Md Muthalif	670925C	6	-	M	P	0.5	-	B/L mild	-	Nil	-	C+O	-	MMC

Mythili's B	6O5667C	1	3	F	A	0.4	0.4	N	N	L II	-	C+O	2	MMC
Merlin	191476B	5	21	F	P	0.7	0.8	L mild	L mild	L V	-	L reimplant	16	MMC
Nandana	603507C	6	8	F	A	0.6	0.7	N	N	Nil	-	Aug+ BNS	2	MMC
Noha Noman	654814C	4	-	M	A	1.2	-	B/L mod	-	Nil	-	Aug	-	MMC
Ponni's B	171030C	3	6	M	A	0.4	0.5	N	N	Nil	-	C+O	3	MMC
Priyanka	559622C	9	-	F	P	0.9	-	B/L mod	-	L V	-	Aug + TUU	-	MMC
Rkhi seal	638835C	8	-	M	P	0.5	-	B/L mod	-	L III		C+O	-	MMC
Rajath Hasan	628236C	8	10	M	A	0.5	0.5	L mild	N	L I	L I	C+O	2	MMC
Rahul Kumar	688243C	11	12	M	A	0.8	-	N	N	Nil	-	C+O	1	MMC
Sanjana Mandal	328724C	12	15	F	A	0.7	0.8	L mod	N	L V	Nil	L reimplant	3	MMC
Sushmitha	654753C	6	-	F	A	0.6	-	N	-	-	-	C+O	-	MMC
Sai Shetty	403389B	9	11	F	P	2.3	1.5	B/L gross	B/L mild	L V	Nil	Aug	2	MMC
Swetha	735584C	2	6	F	P	0.5	0.6	N	N	R II	Nil	C+O	4	MMC
Thomas K Roy	626858C	2	3	M	A	0.5	0.4	N	N	-	-	C+O	1	MMC
Vikas Kumar	760213C	8	-	M	A	0.6	-	N	-	Nil	-	C+O	-	MMC
Akash Sarkar	822076C	2	5	M	P	0.7	0.5	B/L mod	B/L mild	R II	R V	Aug - TUU	3	MMC
Abhishek	909893C	3	6	M	A	0.4	0.4	N	N	R I	Nil	C+O	3	MMC
Dabbu Sharma	829868C	9	-	M	A	0.6	-	N	-	Nil	-	C+O	-	MMC
Dharshini	579419C	1	5	F	P	0.4	0.5	B/L mod	B/L mod	R V	-	C+O	4	MMC
Githa Devi's B	814056C	1	4	F	A	0.4	0.4	R mild	R mild	Nil	Nil	C+O	3	MMC
Garima Jawar	872495C	3	5	F	P	0.5	0.5	B/L gross	B/L mod	Nil	-	Aug	2	MMC
Githa's B	589608C	1	4	M	A	0.4	0.5	N	N	Nil	-	C+O	3	MMC
Karan Kumar	861765C	9	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Lavanya	365223C	2	6	F	A	0.5	0.5	N	N	Nil	-	C+O	4	MMC
Ponnarasan	813488C	12	-	M	A	0.7	-	N	-	L I	-	C+O	-	MMC
Puja Kumari	946239C	6	-	F	P	1.8	-	B/L mod	-	B/L III	-	C+O	-	MMC
Rooba	847644C	5	18	F	A	0.9	0.8	R mod, L gr	B/L mild	L IV	-	C+O	13	MMC
Ambika's B	239457C	4	5	F	P	0.6	0.6	B/L mild	B/L mild	B/L V	-	C+O	1	MMC
Ayush Varma	090466D	2	4	M	A	0.4	0.4	N	N	Nil	-	C+O	2	MMC
Anupama Saha	985185C	1	3	F	A	0.4	0.5	N	N	Nil	-	C+O	2	MMC
Adithya Singh	953633C	6	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Jamuna Kumari	021608D	4	-	F	A	0.4	-	N	-	Nil	-	C+O	-	MMC
Jamsed Uddin	019336D	6	8	M	P	0.5	0.6	L mod	L mild	Nil	Nil	C+O	2	MMC
Githa's B	034947C	5	8	M	A	0.5	0.5	N	N	Nil	-	C+O	3	MMC

Deepanjali	042456D	3	-	F	P	0.4	-	N	-	Nil	-	C+O	-	MMC
Doel Mukerjee	951215C	1	4	F	P	1.3	0.6	B/L mod	N	Nil	-	Aug	3	MMC
Yamini Podar	156163D	6	-	F	P	1.5	-	B/L mod	-	-	-	C+O	-	MMC
Yasmin	160637D	3	14	F	P	1.9	1.4	B/L gross	B/L mod	B/L V	Nil	B/L reimplant - A	11	MMC
Weebee Saha	987409C	0	1	F	A	0.4	0.4	N	N	Nil	-	C+O	1	MMC
V Mohonta	121664D	11	-	M	P	0.4	-	B/L mild	-	B/L IV	-	C+O	-	MMC
Vishnu Pandy	049848D	4	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Vineet V	036123D	6	-	M	A	0.5	-	B/L mod	-	Nil	-	C+O	-	MMC
Vignesh	522749B	7	12	M	A	0.6	0.7	N	N	Nil	-	C+O - Aug + BNI	5	MMC
Usha's B	955364C	1	3	M	P	1	0.5	B/L mild	N	Nil	-	C+O	2	MMC
Tarani Sen	158360D	2	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Thomas Roy	626858C	2	-	M	A	0.4	-	N	-	-	-	C+O	-	MMC
Snehalatha Das	068643C	8	10	F	A	0.9	1	B/L mod	B/L mod	Nil	-	C+O	2	MMC
Rajkumar	815795C	1	3	M	A	0.4	0.5	N	N	Nil	-	C+O	2	MMC
Raju S K	986509C	4	6	M	P	0.4	0.5	B/L mod	B/L mod	B/L V	B/L V	C+O - Aug	2	MMC
Puja maity	143766d	10	-	F	A	1.6	-	B/L mild	-	Nil	-	C+O	-	MMC
Pooja	337237C	6	8	F	P	0.7	0.9	B/L mod	B/L mild	Nil	Nil	V - Aug	2	MMC
Priya Prakash	031173D	12	14	F	A	0.8	0.9	B/L mod	B/L mod	Nil	-	C+ O	2	MMC
Nivetha	042595D	1	3	F	A	0.4	0.4	B/L mild	N	R V	-	C+O	2	MMC
Nithish	054893D	3	5	M	P	1.9	0.8	B/L gross	B/L mild	B/L V	-	V	2	MMC
Malay Bera	099149D	1	3	M	A	0.4	0.3	N	B/L mild	Nil	-	C+O	2	MMC
Mukesh Kumar	024609D	8	-	M	A	0.7	-	N	-	Nil	-	C+O	-	MMC
L Ali Molla	962196C	8	-	M	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Kanman	896802C	2	4	M	A	0.4	0.4	N	N	Nil	-	C+O	2	MMC
Krishna Sumant	015891D	15	-	M	A	0.6	-	N	-	Nil	-	C+O	-	MMC
Sharunya	820083C	1	3	F	A	0.4	0.4	N	N	Nil	-	C+O	2	MMC
Swathi Shaw	634528C	3	5	F	P	1.3	0.9	B/L mod	L mild	B/L IV	L II	Aug	2	MMC
Sudip Das	765698C	3	6	M	P	0.4	0.5	N	N	Nil	-	C+O - Aug	3	MMC
Surya	927255C	5	7	M	A	0.5	0.5	N	N	Nil	-	C+O	2	MMC
Angel Mary	215143D	1	-	F	A	0.5	0.5	B/L mod	-	R V, L II	-	C+O	-	MMC
Amit Mathew	242207D	2	3	M	A	0.6	0.6	N	N	-	-	C+O	1	MMC
Shahid Burnwal	426226C	3	6	M	A	0.4	0.4	N	N	Nil	-	C+O	3	MMC
Anshu Kujur	156830D	6	8	F	P	0.5	0.5	L mod	N	B/L V	Nil	Aug	2	MMC
Debu Haldar	199189D	0	1	M	A	0.4	0.4	N	N	L I	-	C+O	1	MMC

Kabi Arasu	369214D	12	-	M	A	0.7	-	B/L mod	-	Nil	-	C+O	-	MMC
Latha's B	082427D	1	-	M	P	0.4	-	N	-	-	-	C+O	-	MMC
Latha's B	244473D	0	1	M	A	0.4	0.4	N	N	Nil	-	C+O	1	MMC
Munna Kumar	321693D	12	13	M	P	2.5	2.5	B/L mod	B/L mod	L I	-	C+O	1	MMC
Md S Alam	338592D	6	7	M	A	0.5	0.5	N	N	Nil	-	C+O	1	MMC
Muzhu Mathi	263528D	2	-	F	A	0.4	-	N	-	B/L I	-	C+O	-	MMC
Niranjana	223447D	4	-	F	A	0.5	-	N	-	Nil	-	C+O	-	MMC
Pinki Kumari	312830D	1	-	F	A	0.4	-	N	-	Nil	-	C+O	-	MMC
Padmaja	243755D	4	5	F	P	0.4	0.5	B/L mod	-	R II, L II	-	C+O	1	MMC
Prabavathi's B	235725C	6	7	M	A	0.6	0.7	N	N	Nil	-	Aug	1	MMC
Prasanna	217227D	4	5	M	A	0.4	0.5	N	N	Nil	-	C+O	1	MMC
Sathish	109534C	1	7	M	P	1	0.6	B/L mod	N	Nil	Nil	V	6	MMC
Sumathi's B	405224C	3	4	M	A	0.4	0.5	N	N	Nil	-	C+O	1	MMC
Sushmitha S	213678D	8	10	F	P	0.5	0.5	N	B/L mod	R III, L I	-	C+O	2	MMC
Sayeta Bar	084800D	15	16	F	P	0.6	0.7	B/L mod	N	Nil	Nil	Aug	1	MMC
Tanmay Sahu	315567D	14	15	F	A	0.6	0.7	B/L mild	B/L mild	Nil	-	C+O	1	MMC
Yuvaraj	202545D	10	-	M	A	0.8	-	B/L mod	-	Nil	-	C+O	-	MMC
Vanitha' B	833388B	2	3	F	P	2.2	0.7	B/L gross	R mod	R V	Nil	Aug	1	MMC
Suman Ghosh	758450B	6	-	F	P	1	-	B/L mod	-	R IV	-	Aug	-	MMC
Sahasrunam	750429C	1	3	M	P	0.6	0.5	L mod	N	B/L V	Nil	Aug	2	MMC
Arpith Sumali	250591D	9	10	M	A	0.6	0.6	N	N	-	-	C+O	1	MMC
Arnab Roy	268334C	2	8	M	P	0.6	0.6	R mild,	R mild,	B/L V	Nil	B/L reimplant	6	ARM
Rahul Roy	265127C	2	-	M	P	0.6	-	L mod	-	L III	-	L reimplant	-	ARM
Rahul Shaw	368462C	6	12	M	P	0.7	0.9	B/L mod	B/L mod	L V	Nil	TUU	6	ARM
Ashwin Churchil	017020C	10	17	M	A	0.6	0.9	B/L mild	N	Nil	-	C+O	7	ARM
Hasinur Arza	420661C	3	4	M	P	0.4	0.4	N	N	Nil	-	C+O	1	ARM
Mark Sumi	602894B	2	3	M	P	0.6	0.6	B/L mild	B/L mild	B/L V	-	B/L reimplant+B	1	ARM
Mala's Baby	602894B	5	10	F	A	0.5	0.6	N	N	Nil	-	C+O	5	ARM
Animesh Marji	178072C	2	7	M	P	0.5	0.6	B/L mild	L mild	R V	-	R reimplant	5	ARM
Utsaran Kundu	369399C	1	6	M	A	0.3	0.6	L mild	L mild	Nil	Nil	C+O	5	ARM
Druv Kumar Dey	292298C	10	11	M	A	0.7	0.7	N	N	B/L II	-	C+O (App mitro)	1	ARM
Jerry Mathew	385505C	5	8	M	P	1	1.4	L mod	L Mod	L III	-	Aug + BND	3	ARM
Karib	732410C	2	-	M	A	0.6	-	N	-	-	-	C+O	-	ARM
Prathay Biswas	708775C	2	6	M	P	0.5	0.5	N	N	R V, L V	-	B/L reimplant	4	ARM

Rahul	907972B	6	-	M	A	-	-	-	-	-	-	C+O	-	ARM
Adrita Deb	743963C	3	7	M	A	0.3	0.3	N	N	Nil	-	C+O	4	ARM
Druvan Rajesh	643965C	3	-	M	A	0.5	-	N	-	-	-	C+O	-	ARM
Parvatha Varthin	630420C	9	-	F	A	0.6	-	-	-	-	-	C+O	-	ARM
Sankchur Monal	535668C	10	-	M	A	0.6	-	N	-	Nil	-	C+O	-	ARM
Andreg Gomez	837408C	6	8	M	A	0.6	0.6	N	N	-	-	C+O (App mitro)	2	ARM
Abdulla	810009C	4	-	M	A	0.5	-	L mod	-	Nil	-	Aug	-	ARM
Md Arafat	800903C	6	9	M	P	0.9	0.8	L gross	L mild	L V	Nil	L reimplant	3	ARM
Harshvardhan S	133771D	9	12	M	A	0.5	0.6	L mod	L mod	L V	Nil	Aug	3	ARM
Debnath Kisku	917493D	5	15	M	P	0.8	1.3	L mod	L mod	L V	Nil	Aug	10	ARM
Soumya Biswas	117560D	4	6	M	P	0.8	0.9	B/L mod	B/L mild	B/L V	L I	Aug	2	ARM
Shanmugam	031349D	1	3	M	P	0.5	0.8	B/L mod	B/L mild	R IV	R III	Ves	2	ARM
Soumitha Manna	779138B	4	11	F	P	1.9	2.3	R mod	R mod	B/L V	Nil	Aug	7	ARM
Sohail Ahmed	174767C	2	6	M	A	0.6	-	B/L mod	B/L mild	-	-	C+O	4	ARM
Ajay	528468C	1	5	M	A	0.6	0.6	L mild	L mild	B/L V	-	B/L reimplant	4	ARM
Baby Sumandas	212907D	6	7	F	A	0.6	0.6	R mild	N	L III	-	Aug + BND	1	ARM
Latha's Baby	929249C	1	2	F	A	0.4	0.4	N	N	-	-	C+O	1	ARM
Naveen Kumar	181426D	9	10	M	A	0.6	0.8	R mod	N	R V, L II	-	Aug	1	ARM
Shindid Thamin	337203D	7	-	M	A	0.6	-	B/L mild	-	Nil	-	C+O	-	ARM
Soumitra C	405224C	7	8	F	A	0.5	0.5	N	-	Nil	-	C+O	1	ARM
Abhishek Singh	346697D	8	10	M	P	0.7	0.7	N	N	R III, L I	Nil	Aug	2	ARM
Souvit Das	307504C	3	-	F	A	0.5	-	R mod	-	Nil	-	C+O	-	SA+CRS
Kamesh Singh	237417C	6	8	M	P	1.4	1.2	B/L gross	B/L mild	B/L V	R I,	Aug	2	SA+CRS
Gajalakshmi	652963C	13	-	F	A	0.8	-	L mod	-	Nil	-	C+O	-	SA+CRS
Poornima Jana	607360C	12	-	M	P	0.9	-	B/L gross	-	L III	-	Aug	-	SA+CRS
Ramya	574993C	6	10	F	P	0.5	0.6	B/L mod	B/L mod	R V	Nil	Aug	4	SA+CRS
Sujatha Mithra	598190C	4	5	F	P	0.5	0.5	B/L mod	N	R V	-	Aug	1	SA+CRS
Dhannraj S	083763D	3	-	M	A	0.5	-	N	-	Nil	-	C+O (App mitro)	-	SA+CRS
K Parmanik	991746C	11	-	F	A	0.7	-	N	-	Nil	-	C+O	-	SA+CRS
Suganthi's B	389601C	4	-	M	A	0.5	-	B/L mild	-	-	-	C+O	-	SA+CRS
S Mandal	965407C	1	3	M	A	0.4	0.5	N	N	Nil	-	C+O	2	SA+CRS
Ashar Mathew	209764D	1	-	M	A	0.5	-	N	-	-	-	C+O	-	SA+CRS
Nithya Hussain	339809D	5	-	F	A	0.4	-	N	-	Nil	-	C+O (App mitro)	-	SA+CRS
Shubham kumar	241208C	5	7	M	A	0.4	0.5	N	N	-	-	C+O	2	CP

Nayeem	464509C	1	3	M	P	0.4	0.5	L mild	L mild	L III	-	L reimplant	2	CP
Poorni	142332B	10	15	F	A	0.7	0.7	N	N	Nil	-	C+O	5	CP
Sayan Dara	189372C	9	14	M	A	0.6	0.5	N	B/L mild	Nil	-	C+O	5	SCT
Kavitha's B	467911C	1	2	F	A	0.4	0.6	L mild	L mild	-	-	C+O	1	SCT
Shubam K	241208C	4	6	M	A	0.5	0.5	N	N	Nil	-	C+O	2	ADEM
Smrithi B	596526C	11	-	F	P	0.7	-	B/L mod	-	Nil	-	C+O	-	CP
Subadeep B	454358C	10	13	M	P	1.1	1.1	B/L mild	B/L mod	Nil	-	C+O	3	Down's
Vamshi	646945C	7	11	M	P	0.5	0.6	B/L gross	B/L gross	L V	-	L reimplant	4	EDS
Kavia	776770C	7	9	F	A	0.3	0.7	N	L mild	-	-	C+O	2	RP tumour
Keerthana	999142C	1	3	F	P	2.5	1.6	B/L gross	B/L mod	B/L V	-	Ves	2	CP
S Patak	991357C	7	8	F	P	0.5	0.6	L mild	L mild	L II	-	C+O	1	CP
Mansi Choudury	197728D	2	4	F	P	2.3	1.2	B/L gross	B/L mild	B/L V	Nil	Ves	2	Down's
Prabhavati	225413D	8	9	F	A	0.5	0.5	N	N	Nil	-	C+O	1	CP
Amshrah	264985C	3	8	M	A	0.4	0.4	B/L mod	B/L mild	L I	Nil	C+O	5	NNNB
Silambarasan	715802A	10	25	M	A	0.9	1.1	R gross	R gross	-	-	Aug	15	NNNB
Niranjan Kumar	537826C	2	4	M	P	0.7	0.6	B/L gross	B/L mild	Nil	-	Aug	2	NNNB
Akash Barua	708814C	8	9	M	P	0.7	0.7	B/L mod	B/L mod	R V	-	Aug	1	NNNB
Aishwarya	646216C	10	-	F	P	0.9	-	B/L mod	-	B/L IV	-	C+O	-	NNNB
Miher Das	792781C	1	3	M	P	0.4	0.5	B/L mod	B/L mild	B/L V	B/L V	Ves	2	NNNB
Abraham	921337C	13	15	M	A	0.7	0.7	B/L mod	N	Nil	-	C+O	2	NNNB
Abhishek P	133766D	2	-	M	P	2.3	-	B/L gross	-	R IV	-	C+O	-	NNNB
Anna Poorni	605667C	1	3	F	A	0.4	0.4	N	N	L II	-	C+O	2	NNNB
Manikandan	293012D	9	10	M	P	0.8	0.8	B/L mod	B/L mod	B/L V	-	B/L ureterostom	1	NNNB
Naresh Kumar	142356C	3	10	M	A	1.1	0.8	B/L mild	B/L mild	Nil	-	C+O (App mitro)	7	NNNB
Miriam	377569C	5	9	F	A	0.8	0.7	L mod	N	R I, L V	L I	Aug	4	NNNB